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# TUMORS AND CYSTS OF THE NECK

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THE subject of tumors and cysts of the neck is one about which volumes have been written. It is one of the most fascinating, yet puzzling, subjects confronting the internist, surgeon, and pathologist. Much has been discovered about these lesions, but a great deal more remains to be learned about them. Possibly in no other part of the body do so many distinct pathological entities occur in so small an area.

In recent years I have advocated the streamlining of medical papers, but an attempt to apply this method of discussion to a subject of such magnitude is to indeed tax one's ingenuity. Of necessity, one must merely outline the subject, emphasizing only the most important diagnostic and surgical points, and refer the reader to such textbooks as Hertzler[2] and the recent publication by Ward and Hendrick[3] for more detailed study.

For this presentation I have drawn on an experience of a considerable number of patients observed over a period of more than three decades. First, I shall present an outline of the classification to be followed and then shall summarize the most important points, later clarifying these with illustrations.

## CLASSIFICATION OF TUMORS AND CYSTS OF THE NECK

I. *Tumors of the thyroid and parathyroid glands*
  A. Thyroid
    1. Adenoma

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2. Carcinoma
3. Sarcoma

B. Parathyroid
1. Adenoma
2. Carcinoma

II. *Tumors of the salivary glands*
A. Mixed tumor
B. Primary malignancy
C. Cysts

III. *Primary tumors of the lymph glands*
A. Hodgkin's disease
B. Lymphosarcoma
C. Lympho-epithelioma
D. Leukemia
E. Endothelioma

IV. *Secondary tumors of the neck*
A. Metastasis from the buccal cavity
B. Direct extension from the buccal cavity
C. Metastasis from below the clavicle

V. *Benign tumors*
A. Lipoma
B. Myoma
C. Dermoid
D. Chondroma
E. Hemangioma
F. Lymphangioma
G. Atheromatous cyst
H. Sebaceous cyst
I. Fibroma
J. Adenoma
K. Keloid
L. Cylindroma
M. Xanthoma

VI. *Unusual tumors*
A. Mikulicz's disease
B. Carotid body tumor
C. Neuroblastoma
D. Neurofibroma
E. Ganglioneuroma
F. Boeck's sarcoid

VII. *Cysts—fistula*
- A. Thyroglossal
- B. Branchial
  1. Benign
  2. Malignant
- C. Hygroma
- D. Epidermal

VIII. *Inflammatory lesions*
- A. Nonsuppurative lymphadenitis
- B. Suppurative lymphadenitis
- C. Tubercular lymphadenitis
- D. Diffuse cellulitis (Ludwig's angina)
- E. Actinomycosis
- F. Blastomycosis
- G. Sporotrichosis

No classification ever has and probably ever will prove satisfactory to those interested in this subject and this one compiled from the work of others, as well as myself, is offered merely as a working hypothesis.

The large and debatable subject of thyroid tumors might be summarized as follows: Where preventive work has been carried on in certain areas for several decades as it has in Switzerland, Ohio, Michigan, and Wisconsin, the incidence of adenomatous goiter has been markedly decreased by the administration of iodine to the school children. It has been generally believed that malignant lesions of the thyroid develop in a pre-existing adenomatous goiter, and the incidence varies from as high as 20 per cent in the solitary adenoma of the male to four per cent in the multiple adenomatous group. A high percentage, 31 per cent, in my own series of 53 cases was not suspected prior to operation. This group responds favorably to surgical treatment and irradiation, in contrast to the diffuse adenocarcinoma group. The papillary adenocarcinoma type, often seen in young persons, is prone to metastasize locally to the adjacent lymph glands and generally offers a favorable prognosis. This class formerly was known as aberrant or lateral thyroid. The rare sarcoma is highly malignant. I have had one patient with endothelioma who developed a recurrence 24 years after thyroidectomy and radium therapy. She is still alive after subsequent deep x-ray therapy. Radioactive iodine has not cured a patient with a malignant thyroid, but it is helpful in some instances.

Parathyroid tumors are relatively rare, may not be apparent locally even to surgical exploration, are evidenced by hypercalcemia

and changes in the osseous structure, and may be associated with renal calculi. Their removal may result in a spectacular alleviation of symptoms.

Salivary gland tumors may be cystic, benign, mixed, or primarily malignant. The important point to remember about the commonest of these lesions, a mixed tumor of the parotid gland, is to remove it early while the capsule is intact. If this is done a cure may be expected; otherwise it may be necessary to sacrifice one or more branches of the facial nerve. Various operative procedures have been suggested to remove the tumor and preserve the facial nerve and recently some improvements in technic have been proposed by McNealy and others.

None of the primary tumors of the lymph glands respond successfully to treatment. Nitrogen mustard gas and x-ray therapy merely delay the inevitable. There is no clearcut differentiation between many of the tumors in this group, lymphoblastoma being a generalized term indicating that the tumor is due to a proliferation of the lymphoid tissue. While Hodgkin's disease is usually seen in younger persons and lymphosarcoma in older adults, there are many exceptions. In differentiating Hodgkin's disease from other glandular tumors of the neck, one usually finds that this disease causes a discrete enlargement of one or more lymph glands usually situated in the posterior triangle of the neck. Subsequently glandular adenopathy may appear in the axilla and groin, and an x-ray film may demonstrate mediastinal involvement. A dense fibrosis develops as the disease progresses. A positive diagnosis is determined only by making a biopsy and finding the characteristic Sternberg-Reed cells. X-ray therapy is considered the best first line of defense; some patients respond remarkably well and live for years, while others develop fever, secondary anemia, and malaise and succumb in a few months.

In lymphosarcoma, the disease tends to invade the capsule of the lymph glands and extend to surrounding tissues; the cells are uniform and fibrosis does not occur. Hodgkin's disease, on the other hand, tends to affect successive groups of glands in the manner of a constitutional disease. A sarcoma begins in a single gland or closely related glands, while in Hodgkin's disease one or more groups of glands is involved. A sarcoma grows rapidly, tends to bulge up beneath the upper portion of the sternocleidomastoid muscle, is apt to invade the skin so that it becomes reddened, and even appears to fluctuate. Surgical removal may often prove to be a formidable procedure. In some cases in which such a diagnosis had previously been determined by others, I have been frankly surprised to find not a sarcoma but perhaps an infected branchial cyst. Although life

expectancy is often a matter of only a year or two in sarcoma, an occasional patient treated early may be carried several years with surgery and x-ray. These tumors kill, not so much by affecting the general health, as in Hodgkin's disease, but rather by attacking the important adjacent structures, the trachea, esophagus, and large vessels.

A lympho-epithelioma is apt to appear first as an enlarged gland just beneath the angle of the jaw. Although it may arise from the nasopharynx, in many cases the primary source of the tumor may never be located. The diagnosis is confusing not only to the surgeon but to the pathologist as well, since both lymph and epithelial cells may coexist and the tumor be indistinguishable from a sarcoma. This tumor is extremely painful, and its appearance may proceed or follow the appearance of a pharyngeal tumor. It is firmer and more fixed than the sarcoma and tumor in Hodgkin's disease, and often remains unilateral.

An endothelioma clinically resembles the tumors of this group but is far less malignant; patients suffering from this unusual lesion may live for many years after surgery and x-ray therapy. An extremely rare case was that of a large hemangio-endothelioma of the salivary gland which I removed from a four month old baby who recovered.

The story of leukemia is too well known to need reiteration here. Whether it is the acute fulminating type that so often strikes a child or young adult or the chronic form that more commonly attacks those in middle age, none survive. It is perhaps the most deadly of all glandular diseases. Fatigue, bleeding gums, an enlarged spleen, glandular adenopathy, fever, loss of weight, altered blood picture, and bone marrow findings lead to diagnosis. X-ray therapy and mustard gas prolong life but offer no cure.

A secondary tumor of the neck may give the first indication of disease elsewhere, as Virchow's node may indicate carcinoma of the stomach. Various lesions of the buccal cavity, such as carcinoma of the tongue, frequently manifest themselves by metastasis to the cervical lymph glands.

In the list of benign tumors of the neck the most frequently found and the simplest to remove is the lipoma. Soft and freely movable, its diagnosis is seldom puzzling, yet because of its location it may occasionally resemble a dermoid or a thyroglossal cyst.

Next in frequency is the common sebacious cyst, equally easy to recognize and dispose of, although one should emphasize that it must be removed entirely to prevent recurrence. This is also true in the case of the harmless lipoma.

The myoma, dermoid, fibroma, and remainder of this group are less common, seldom troublesome, and chiefly of pathological interest. In my experience the keloid is best treated by excision with the electrosurgical knife followed immediately with radium.

Of the unusual tumors of the neck, I wish to mention briefly Mikulicz's disease, of which less than 100 cases have been reported. One case was that of a middle-aged man who was the first patient to be treated successfully with penicillin. The second patient, a young mother, required surgical removal plus penicillin to effect a cure. This disease is characterized by the absence of salivary flow, extreme parchment-like condition of the tongue, narrowing of the palpebral fissures, and involvement of the salivary glands.

The carotid body tumor is uncommon, less than 400 cases having been reported. Though this tumor may be malignant, its rate of growth is protracted so that patients may live for years. The tumor is so slow to invade the carotids that its early diagnosis may permit removal without too great a risk. The external carotid is involved first, but, when the common carotid becomes invaded, ligation of this vessel in older persons is attended with a high mortality. This tumor may push forward the sternocleidomastoid muscle, giving the appearance of a sarcoma, but at operation it is seen to arise from the carotid notch.

Still more unusual are a small group of tumors of nerve origin, the neuroblastoma, neurofibroma, and ganglioneuroma, all of which clinically suggest Hodgkin's disease and are only recognized at operation. Boeck's sarcoid tumor of the neck may suggest Hodgkin's disease in an early stage. Usually skin manifestations and uveitis accompany a sarcoid lesion. This is a benign lesion of unknown origin.

The thyroglossal cyst, the result of a congenital abnormality in the development of the thyroid gland, is situated in the midline of the neck, anywhere between the thyroid and the base of the tongue. It is the result of a persistent thyroglossal duct, which may end at the hyoid bone or pass through it, above it, or below it. When the duct extends to the base of the tongue, its surgical removal may be difficult, and failure has not infrequently subjected many patients to repeated operation. A thyroglossal cyst may persist until middle age without causing symptoms; it may become infected and rupture spontaneously only to heal and later repeat the process. Sometimes it is lanced and then a discharging sinus may develop. Sistrunk's classical procedure still offers the best approach to the removal of these cysts. I have followed his technic in operating upon a series of 28 patients, except that all operations have been done under

nerve block anesthesia. Preferably, I postpone operation in children until the fifteenth year, so that the child is able to cooperate better. The cyst is dissected to the hyoid bone, the center of which is resected, and then, if it continues to the base of the tongue, its course is carefully followed and all tissue removed. The hyoid bone is usually resutured with fine chromic catgut and the incision is closed without drainage. If all of the cyst is removed, recurrence will not develop.

The branchiogenic cyst results from a failure of the upper part of the gill clefts to become obliterated. It has a deep origin often arising from between the jugular vein and the carotid artery and bulges into the neck as a smooth soft mass from beneath the sternocleidomastoid muscle. It may become infected and be mistaken for a sarcoma. In two instances in my series, operation revealed a malignant change. The removal of the cyst involves careful dissection among the important structures of the neck and may be accomplished with nerve block anesthesia.

Thyroglossal and branchiogenic fistulous tracts may occur and may undergo malignant change. Finally, there remains the group of inflammatory lesions of the neck which is apart from the subject of this discussion.

In conclusion, it may be said that tumors and cysts of the neck form one of the most interesting diagnostic and surgical problems, one that in many instances offers insurmountable obstacles and yet frequently rewards the surgeon with unexpected and gratifying results.

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# ANEURYSM OF THE SUBCLAVIAN ARTERY ASSOCIATED WITH CERVICAL RIB

## Report of Two Cases

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THE occurrence of an aneurysm of the subclavian artery associated with a cervical rib is relatively infrequent. The pathological, anatomical, and physiological mechanisms involved in the formation of this type of aneurysm are still incompletely understood. Two cases are presented which illustrate the clinical manifestations of this syndrome, and a new method of surgical repair is presented which has not been reported previously, to our knowledge.

A review of the literature on this subject dating from 1916, when Halstead[5] reported 27 instances of aneurysm or some degree of dilatation of the third part of the subclavian artery from a résumé of 716 cases of cervical rib, disclosed relatively few cases reported and a paucity of investigational work carried out in the attempt to clarify the pathogenesis.

In 1931, Billington[2] reported a case of aneurysm associated with cervical rib which was adherent to the lower cord of the brachial plexus. The blood Wassermann was negative. The aneurysm was doubly ligated and excised. The cervical rib was left in place since it did not seem to cause any pressure on the cords of the brachial plexus.

In 1934, Quinn and Davison[11] reported a case of a 75 year old female who had a pulsatile swelling in the left supraclavicular fossa of 30 years' duration. This had been asymptomatic until one month prior to admission, when after a fall, she had begun to experience pain, paresthesia, and loss of strength in the left arm. Examination disclosed a well developed cervical rib on the left. The blood Wassermann was negative. Because of the patient's age, no operation was performed.

In 1937, Lindskog and Howes[7] reported a case of aneurysm of the subclavian artery associated with cervical rib. At the time of

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surgery, the rib was found to be impinging on the under surface of the artery between the scalenus anticus and medius muscles. The distal 4 cm. of the rib was rongeured away, and the aneurysm was left intact. The patient made a good recovery with cessation of symptoms; the aneurysm, however, did not decrease appreciably in size.

In 1940, MacFee[8] reported a case of aneurysm associated with cervical rib. The subclavian artery was compressed between the tip of the rib and insertion of the scalenus anticus tendon and the normal first rib. The scalenus tendon was resected and the rib cut away with rongeurs. The patient made an uneventful recovery. Nine months later, however, the patient had a recurrence of symptoms due to regeneration of the distal end of the cervical rib. The patient was re-operated with complete removal of the rib. There was no recurrence of symptoms within the following five months.

In 1939, Eden[3] reported 3 cases of aneurysm of the subclavian artery. In 2 cases a cervical rib was found compressing the artery against the clavicle. In these cases the enlarged end of the cervical rib was rongeured away. In the third case, there was no cervical rib present, but the artery was observed to be compressed between the clavicle and the normal first rib. At this time, simple scalenotomy was done. This operation did not produce any relief; consequently, one month later the patient was re-operated and the first thoracic rib was rongeured away. The patient made a satisfactory recovery.

In 1944, Walshe, Jackson, and Wyburn-Mason[13] reported 2 cases of subclavian aneurysm. The first was associated with a congenital deformity of the upper dorsal rib as well as an osteoma of the rib. At operation, the aneurysm was found to be pushed forward by the osteoma of the first rib. The osteoma was removed by rongeurs, the artery ligated, and the aneurysm excised. The second case revealed, at operation, an aneurysm just distal to compression of the artery between the tendon of insertion of the scalenus anticus muscle and an exostosis of a cervical rib which was lying posteriorly. They presented a third case of probable aneurysm which was not verified by operation.

In 1936, Baumgartner, Clerc, and Macrez[1] reported an aneurysm of the third part of the subclavian artery just distal to its impingement on the sharp edge of the cervical rib. The patient made a satisfactory recovery following resection of the aneurysm, ligation of the artery, and resection of the cervical rib.

The literature presents many examples of cervical rib, or scalenus anticus syndrome, which produced predominantly vascular manifestations. Other cases are reported concerning aneurysm of the sub-

clavian artery; however, in these cases the pathogenesis of the condition was either obscure or unrelated to a cervical rib or scalenus anticus syndrome. More recently, there have been reports of a condition, termed costoclavicular compression, involving the subclavian artery with resulting vascular phenomena; however, at this time, the concurrence of an aneurysm has not been reported as a complication of this condition.

## Presentation of Cases

Case 1. A white male, aged 52 years, was admitted to the Veterans Administration Hospital in Muskogee, Okla., on March 7, 1949. The patient was an oil field pumper.

*History of Present Illness:* One year prior to admission the patient first noticed infrequent numbness and tingling sensations in the little and ring fingers of the right hand. These sensations had become progressively more frequent and more severe. The patient noted a wasting of the muscles of the hand, particularly the thenar and hypothenar eminences and the dorsal interosseous muscles. The patient had noted, also, a fullness in the right supraclavicular fossa and had experienced a vague, but dull, boring-like pain in the supraclavicular fossa which radiated to the top of the shoulder.

*Physical Examination:* Examination revealed a fairly well developed white male; height, 68.5 in., weight, 150 lbs. The positive physical findings were as follows: Prominence of the subclavian artery passing through the right supraclavicular fossa, tenderness to palpation in this area; hard, unyielding structure behind the artery; marked atrophy of the thenar and hypothenar eminences and of the dorsal interosseous muscles with typical "snuff box" phenomenon in the right hand. Further examination revealed that the finger tips of the right hand were smoother than those on the left. The right hand was somewhat cooler than the left; however, there was no change in the color of the two hands. There was approximately 50 per cent loss of grip in the right hand and in the muscles of flexion and extension of the right wrist. The radial pulse was absent on the right and normal on the left. The blood pressure on the right side was not obtainable; blood pressure on the left side was 90/60. There were no visible pulsations in the subclavian artery. No bruit was heard.

*Laboratory and X-ray Findings:* Complete blood counts and urinalysis were within normal limits. The blood Wassermann and Kline were negative. X-ray examination revealed an anomalous development of the first rib on the right side with considerable bowing upward at a point approximately 6 cm. from its head and a widening of the rib anterior to this.

*Operation:* On March 22, 1949, through a supraclavicular incision, the scalenus anticus muscle was found to be hypertrophied and taut. It inserted by a large, flat fibrous tendon to the tip of the anomalous first rib at the costochondral junction. The subclavian artery was found compressed anteriorly against the scalenus anticus muscle at its insertion. The artery was displaced upward and was lying on the flat surface of the anomalous rib. The artery was acutely angulated as it arose and passed through the narrowed scalene triangle and then descended beneath the clavicle (fig. 1). Distal to the point of pressure between the scalenus anticus muscle and the anomalous rib, there

was a fusiform dilatation of the artery measuring approximately twice the diameter of the caliber of the normal vessel and about 2.5 cm. in length. The lower root of the brachial plexus was sharply angulated and compressed as it traversed the narrowed scalene triangle. The scalenus anticus muscle was divided about 2 cm. from its point of attachment to the rib. The enlarged broad angle of the rib was rongeured away. The subclavian artery, aneurysm, and lower cords of the brachial plexus then assumed their normal position and were noted to be free of any tension or pressure. The aneurysm was completely encircled with Gelfoam in an effort to strengthen its wall.

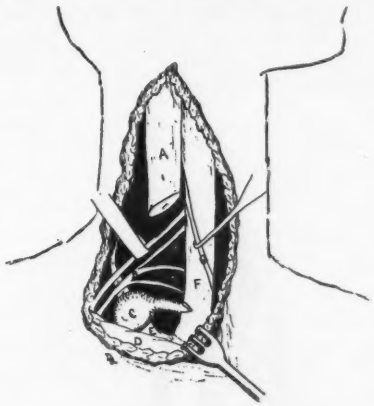


**Fig. 1 A. Sternocleido-mastoid muscle. B. Brachial plexus. C. Aneurysm of subclavian artery. D. Clavicle. E. Transverse process 7th cervical rib. F. Scalenus anterior muscle. G. Phrenic nerve.**

Postoperatively, there was no return of the radial pulse. The patient had relief of the numbness and tingling sensations in his hand. At the time of his discharge on April 25, 1949, there had been a slight return of power in the muscles of the right hand and the flexor and extensor muscles of the right wrist. The patient was seen again on June 30, 1949, because of the recurrence of the weakness in the right hand and wrist. He also complained of a sharp pain in the ulnar distribution of the hand. There was no radial pulse on the right side; however, the color and temperature of the skin of the right hand were the same as those of the left hand.

On July 7, 1949, the operative wound was reopened. An incision was made excising the old scar. The scalenus anticus muscle was found re-attached to the former site at the junction of the anomalous rib and sternum. There were marked scars and inflammatory changes at this site, compressing the lower roots of the brachial plexus and the old aneurysm. The scalenus anticus muscle was severed at its point of insertion and approximately 2.5 cm. excised. The upper end was retracted out of the operative field. The roots of the brachial plexus were freed from their adhesions and left lying free in the wound. The aneurysm was firmly enclosed in a mass of fibrous tissue and was not disturbed.

Postoperatively, the patient experienced an uneventful convalescence. He reported four and a half months after surgery that he

had been free of pain and that there had been steady improvement in the strength of his right hand and forearm.

CASE 2. A white male, aged 36 years, was admitted to Hillcrest Memorial Hospital on March 30, 1949. Occupation, painter.

*History of Present Illness:* One week before admission the patient first noticed a pulsating mass in the right supraclavicular fossa. According to the patient's statement, confirmed by his wife, this mass had not been present prior to one week before admission. It was first noticed one morning when the patient was shaving. In retrospect, the patient recalled that he had experienced rather infrequent vague sensations of discomfort in his right shoulder which radiated up his neck during the preceding five or six weeks. These occurred while painting with his arm elevated above his head.

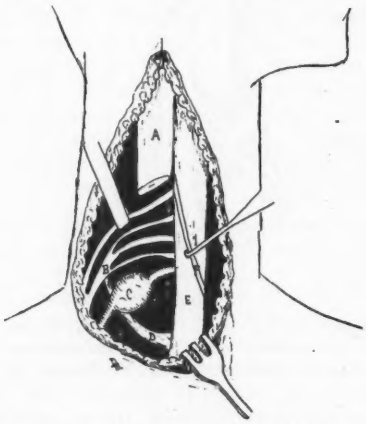


Fig. 2 A. Sternocleido-mastoid muscle. B. Brachial plexus. C. Aneurysm of subclavian artery. D. Transverse 7th cervical rib. E. Scalenus anterior muscle. F. Phrenic nerve.

*Physical Examination:* Examination revealed a pulsating mass in the right supraclavicular fossa which measured approximately 4 cm. in diameter. A prominent bruit was heard over this mass. Deeper in the fossa there was noted a hard unyielding structure against which the aneurysm could be compressed, with obliteration on the radial pulse. There were no sensory changes. Examination of the muscles of the right upper extremity revealed no evidence of atrophy. The radial pulse was present and equal bilaterally. Adson's maneuver did not alter the pulse on the right side. However, raising the right arm above the head and turning the head to the opposite side caused an obliteration of the right radial pulse. The same maneuver on the left side produced a minimal decrease in the pulse.

*Laboratory and X-ray Findings:* Complete blood counts and urinalysis were within normal limits. The blood Kline was negative. X-rays revealed an aberrant rib originating in the transverse process of the seventh cervical vertebra on the right side and inserting at the costochondral junction of the normal first rib.

*Operation:* On March 31, 1949, the supraclavicular fossa was explored. The scalenus anticus muscle was noted to be markedly hypertrophied and taut. The muscle was inserted by a heavy fibrous band to the distal end of the aberrant cervical rib at its junction with the first dorsal rib and sternum. The subclavian artery was noted to be compressed anteriorly against the scalenus anticus muscle and impinging upon the edge of the cervical rib posteriorly. Just distal to this point the artery enlarged to form a pulsating fusiform aneurysm, measuring approximately 3.5 cm. in diameter (fig. 2). The scalenus anticus muscle was then severed at its point of insertion to the aberrant rib and the distal 2 cm. of the muscle excised. Following the releasing of the pressure, the artery assumed its normal position. The cervical rib was examined to determine its relationship to the clavicle; it was felt that the cervical rib was not compressing the subclavian artery in the space between the clavicle and the normal first dorsal rib, so it was left intact. After 20 minutes, the aneurysm appeared to be approximately half its size prior to scalenotomy. The aneurysm was then completely encircled with Gelfoam. At that time, the aneurysm and lower cords of the brachial plexus were noted to be lying free, there being no evidence of pressure from surrounding structures.

The patient's convalescence was uneventful, and he was discharged from the hospital on April 7, 1949. On discharge, there was no visible or palpable pulsating mass in the supraclavicular fossa. The radial pulses were bilaterally equal in all maneuvers. The patient reported seven months following surgery that he had remained symptom free.

## Discussion

Many hypotheses, some of which are supported by investigative work, have been suggested in the attempt to explain the formation of an aneurysm distal to the most obvious point of compression, which is between the cervical rib or the abnormal first dorsal rib and the scalenus anticus muscle or the clavicle.

In 1916, Halstead[5] was able to reproduce experimentally dilatation of any artery distal to a point of compression. In 2 dogs, he produced a rise in diastolic pressure and a fall in systolic pressure with arterial enlargement distal to a point of partial occlusion of the abdominal aorta with the use of a metallic band. No explanation was given for these phenomena.

In 1938, Baumgartner, Clerc, and Macrez[1] reported a case of subclavian aneurysm and offered as the physiological and pathological basis the theory of compression of the vasa vasorum of the vessel wall due to moderate pressure between the cervical rib and the scalenus anticus muscle or clavicle. This decrease in blood supply to the vessel wall produces trophic changes in the wall distal to the point of compression, with resultant weakness and dilatation.

A fourth theory of the mechanism of vascular symptoms relating to the subclavian artery is advanced by Falconer and Weddell,[4] Mc-

Gowan and Velinsky,[9] and Shumaker.[12] They feel that individuals who have an abnormally narrow space between the clavicle and the first rib can further narrow this space in certain positions of the shoulder girdle, notably backward displacement and downward fixation of the shoulders with hyperextension of the head and neck. They suggest that these movements produce small but repeated trauma to the third portion of the subclavian artery as it passes between the clavicle and rib. This compression is distal to the usual location of the aneurysms described in the literature.

In our cases, 1 and 2, we have distinct evidence of proximal compression of the subclavian artery by a hypertrophied scalenus anticus muscle.

## Comment

The "sudden" occurrence of the aneurysm in the second case is difficult to explain by any of the above mentioned mechanisms of aneurysm formation. The aneurysm was of considerable size and had been noted for only one week prior to admission. The patient had no manifestations of an obliterating endarteritis, as has been described in Baumgartner's case and by Leriche. Further, there was no evidence at the time of operation of any narrowing of the costoclavicular space. It would seem that a more dynamic mechanism is involved since the aneurysm decreased in size by 50 per cent within 20 minutes following scalenotomy. Within one week, there was no external evidence of aneurysm and the radial pulses were then bilaterally equal in all respects.

In the first case, there was evidence of arterial insufficiency and trophic changes in the fingertips which had been present for one year. At the time of the first operation, there was direct evidence of a narrowing of the intercostoclavicular space. Three and a half months after the second operation, we were unable to determine any changes in the size of the aneurysm, due to the heavy scar formation around the aneurysm. It was felt that the artery had been subjected to trauma and compression from the broad angulated rib and the hypertrophied scalenus anticus muscle.

We feel that these aneurysms should not be resected, as has been the treatment in the past. Wrapping them with Gelfoam, plastic, or fascia lata produces a strong, fibrous scar which tends to decrease the size of the aneurysm after the causative factors have been removed. In all cases, the scalenus anticus muscle should be widely resected and any bony pathology corrected.

## Summary

Two cases of subclavian aneurysm associated with cervical rib,

or abnormal first dorsal rib, are presented and a new method of treatment described. A review of the literature and possible mechanisms of the formation of these aneurysms are discussed.

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# CONGENITAL ATRESIA OF THE EXTRAHEPATIC BILE DUCTS*

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IT IS apparent from the fact that more than 300 cases of congenital atresia of the extrahepatic bile ducts have been reported, that it is not an unusual disease. Although many of these cases were reported early in this century, it was not until 1927 that Ladd[1] performed the first successful operation for relief of congenital atresia of the bile ducts. Since that time, the same author has presented a large series of cases and in addition, many isolated cases of bile duct anomalies have been reported with a fairly high percentage of good results from surgical intervention.[2,3,4] A more recent report by Hicken and Crellin[5] states that approximately 30 per cent of all cases of congenital atresia of the bile ducts can be corrected by surgery so that recognition of the condition is important. In addition, Behrend[6] has stressed the fact that since so much attention has been paid to erythroblastosis, the anomaly, congenital atresia, may be overlooked until it is too late to operate, and the pediatrician, as well as the surgeon, should keep the possibility of this disease in mind in all cases. For this reason a review of the subject seems indicated together with a report of 3 cases of jaundice resulting from congenital atresia of the extrahepatic bile system.

The etiology of this atresia is, of course, unknown but the condition is thought to be due to a failure of the bile ducts to evolve or a failure of the solid embryonal tissue to resolve into the tubelike structures consisting of the hepatic ducts, the common duct and the gallbladder. The incidence is statistically unknown but it is felt that it is not uncommon and the possibility of its recognition should always be borne in mind.

From an anatomical standpoint, all or any of the component parts of the extrahepatic bile system may be involved and the atresia may be complete or segmental and may occur in any part. This is, of course, extremely important to the surgeon in correcting the defect.

The presenting symptom in this condition is jaundice which usually occurs at about 4 weeks of age but may be present from birth. It is apparently painless and is usually severe, increasing,

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and is persistent. Clay-colored stools are always present and the urine is deeply bile stained. The liver is usually enlarged and easily palpable. There may be some intolerance to fatty foods but usually these children appear to be in much better health than the severity of their condition would indicate. From a differential standpoint, congenital atresia of the bile ducts may be confused with (1) erythroblastosis, but this condition can be ruled out by appropriate blood studies or by the fact that the erythroblastotic infants frequently die promptly while the infants with congenital atresia usually live indefinitely; (2) jaundice of hemolytic sepsis, which is usually associated with fever, leukocytosis and other signs of toxicity; but the two conditions may be easily differentiated by examination of the stools which are acholic in the jaundice of atresia; (3) congenital syphilis may present a very similar picture to congenital obstruction but the blood Wassermann report of the fetus and the mother and x-ray of the long bones usually serve to rule out this disease; (4) congenital hemolytic icterus seldom affects young children and it is easily recognized by the increased fragility of the erythrocytes: (5) icterus neonatorum occurs in approximately one third of all newborns but is present shortly after birth and soon subsides; (6) inspissated bile or mucus or calculi in the common duct or its branches cannot be differentiated from congenital atresia and must be considered along with the disease as in most cases surgical intervention is necessary in order to correct the condition.

The treatment of congenital atresia of the bile ducts is entirely surgical, but the diagnosis cannot be positively made until after at least 1 month of age and these patients should not be operated upon prior to that time. However, if the operation is delayed too long, the general condition of the child becomes poor and the operative risk is greater. The object of the operation is to provide a new channel through which the bile may flow. In approximately 30 per cent of the cases such a condition exists but there are, of course, many anatomical situations in which no surgical treatment is of avail. At operation, Ladd and Gross[1] advised that the ducts of the gallbladder be distended with saline solution so that they can be more easily identified but Hickens and Crellin[5] advised injection of a radio-opaque media into the gallbladder or through the ampulla of vater in order to outline by roentgenography the ducts of the system, which may be patent. This seems to be a marked advance in the treatment and will probably be used more frequently. As has been mentioned, from a statistical standpoint, approximately 70 per cent of these cases are inoperable but a laparotomy is the only way that the cases can be differentiated and should be advised in all cases in which the diagnosis is made.[1]

The following 3 cases are briefly reported:

CASE 1. W. T. H., Jr., a 2 month old white child, was admitted to the Elizabeth Buxton Hospital on Oct. 18, 1943, with a history of jaundice since birth which had persisted and grown worse. The family history was noncontributory. The child was delivered spontaneously after an uneventful pregnancy. The mother's Wassermann was negative. On physical examination a normally developed, intensely jaundiced and dehydrated 2 month old infant was seen. The heart and lungs were normal. Abdominal palpation revealed the liver and spleen to be enlarged, the liver being almost to the level of the umbilicus. Laboratory studies showed the icterus index to be 74 units, fragility test normal, blood Wassermann normal and the stools were acholic. The urine showed bile and the blood count was as follows: erythocytes 4,360,000 per cm., leukocytes 7,900 per cm., of which 44 per cent were neutrophils, 52 per cent lymphocytes, and 4 per cent were eosinophils. Hemoglobin was 84 per cent of normal. A cholecystogram was attempted, the dye being given intravenously and intramuscularly and x-ray reported a non-functioning gallbladder. While in the hospital, the child was treated with fluids subcutaneously and after several days the icterus index had risen to 90 units. At this time a diagnosis of congenital atresia of the common bile ducts was made and operation advised. This was done seven days after admission and absence of the hepatic and common ducts was found as shown in figure 1, and it was thought to be a hopeless case. A cholecystostomy was done in an effort to relieve any pressure on the biliary system. The infant did very poorly and died three days after operation. An autopsy examination was done and the pathologist's findings showed a congenital anomaly of the biliary ducts (absence of the hepatic ducts) and cirrhosis of the liver.

**Fig. 1. Congenital atresia of the hepatic and common ducts.**

CASE 2. J. H. G., a 4 month old colored male infant, was admitted to the Elizabeth Buxton Hospital on Feb. 1, 1946, with a history of persistent increasing jaundice since birth. The history was non-contributory otherwise. The child had been delivered spontaneously after an uneventful pregnancy. The mother's blood Wassermann was negative. Physical examination showed a 4 month old colored infant extremely jaundiced. The head was grossly normal, the conjunctivae were yellow and the skin was dry. The heart and

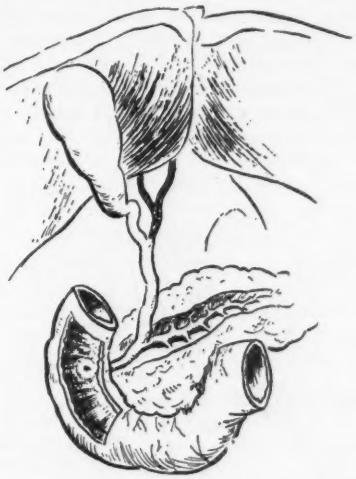

**Fig. 2. Congenital atresia of the hepatic ducts.**

lungs were normal. The abdomen was distended and palpation revealed a large mass extending almost to the iliac crest, more prominent on the right side. Laboratory studies disclosed the blood count to be as follows: erythocytes 3,320,000 per cubic millimeter, leukocytes 7,500 per cubic millimeter, of which 45 per cent were lymphocytes and 3 per cent monocytes. Hemoglobin was 65 per cent of normal. The urine was negative except for bile. A blood Wassermann examination was negative. The icterus index was 109 units and the fragility test was normal. The blood urea was 36 mgm. per cent. The child was operated upon on Feb. 6, 1946, and the right and left hepatic ducts and the common hepatic duct were not found as shown in figure 2. The gallbladder was small, and as far as could be determined, the cystic and common ducts were normal. During the course of the operation, in an effort to find the ends of the hepatic ducts, the gallbladder was almost entirely freed from its bed and the fundus was exteriorized through the wound and was opened. The postoperative course was uneventful except for increasing jaundice. There was a large amount of bile drainage from the open end of the gallbladder but it was thought that this was bile serum rather than bile. This child was discharged on Feb. 17, 1946, the tenth postoperative day, as improved and at the time the icterus index was 147 units. This child was followed as an out patient for 12 months during which time his general condition remained good but the jaundice steadily increased and the liver increased in size also.

CASE 3. M. M. This baby, a colored male twin infant, was delivered prematurely at the Elizabeth Buxton Hospital on March 15, 1948, after a seven months' pregnancy. The mother's pregnancy was otherwise uneventful. The mother, a registered nurse, and child were discharged from the hospital on March 21 in good condition but two months later on May 19, he was readmitted with a history of jaundice for two days and clay-colored stools for three weeks. The child's growth up to the time of admission was apparently normal. Abdominal palpation revealed a large nodular liver. Laboratory examination showed the blood count to be as follows: erythocytes 3,790,000 per cm., leukocytes 10,450 per cm., of which 16 per cent were neutrophils, 84 per cent lymphocytes. Hemoglobin was 72 per cent of normal. The Wassermann examination was negative and the urine showed bile and a faint tract of albumin. The icterus index was 33 units. A diagnosis of congenital atresia of the extrahepatic bile ducts was made and the child was prepared for opera-

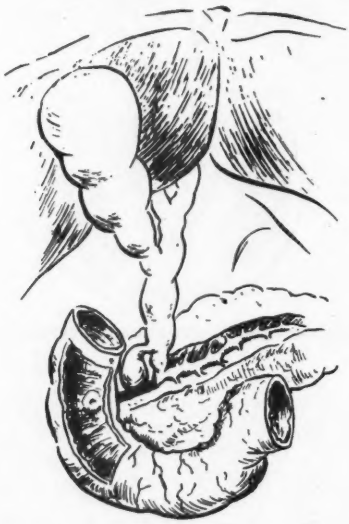

Fig. 3. Diverticulum of the cystic duct with compression of the common duct.

tion, by infusions and blood transfusions. At the time of operation, 15 days after admission, the child's icterus index was 66.5 units. After the abdomen had been opened a diverticulum of the cystic duct pressing upon and constricting the common duct, was found as shown in figure 3. This condition was relieved by dissecting the diverticulum away from the common duct. The patient had a very stormy postoperative course developing first, paralytic ileus with marked distention, followed by acidosis and then pneumonia and finally by a partial dehiscence of the operative wound. Despite these many complications, the child survived and was discharged three weeks following the operation. This child has been followed as an out patient until the present time and there has been no recurrence of the jaundice and his growth has been entirely normal.

## Summary

A brief résumé of congenital atresia of the extrahepatic biliary ducts has been presented with a report of 3 cases.


## Conclusion

1. Congenital atresia of the extrahepatic biliary system is not an uncommon condition.

2. The diagnosis of congenital atresia of the bile ducts must be considered when jaundice is present in the newborn.

3. The condition must not be confused with erythroblastosis.

4. Surgical intervention is always indicated and will result in the cure of approximately one third of the cases.

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# INDICATIONS FOR LUMBAR SYMPATHECTOMY

## With Notes on the Use of Continuous Sympathetic Block*

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DESPITE the fact that lumbar sympathectomy is a technically simple operation that is of little risk to the patient, many patients are still being denied this procedure who would benefit from it. In many instances this is due to a lack of familiarity with what a lumbar sympathectomy has to offer for many of the abnormal conditions found in the lower extremities. Therefore, a review of the indications for lumbar sympathectomy in so far as they are understood at the present time is justified.

The use of a continuous lumbar paravertebral sympathetic block maintained by fractional instillation of procaine as recently described[1] has been of some help in selecting patients for lumbar sympathectomy. In essence, the continuous block consists of repeated (every three to four hours) instillation of procaine mixed with penicillin through an indwelling polyethylene tubing into the vicinity of the second lumbar ganglion. The technic has not been changed since its institution, except that a special 5 in., No. 17 needle** and a small caliber polyethylene tubing is used now instead of the original Tuohy needle and catheter.

It is not my purpose to discuss the relatively rare indications for sympathectomy in abdominal and pelvic conditions, such as Hirschsprung's disease and dysmenorrhea, but rather to consider its indications from the standpoint of the lower extremities.

Following surgical removal of the lumbar sympathetic chain several changes occur in the corresponding lower extremity.

### A. *Improvement in Circulation*

The vasoconstrictor impulses transmitted over the sympathetic pathways are interrupted. The amount of vasodilatation resulting from sympathectomy is determined by the effectiveness of the vasoconstrictor impulses on the vessel walls. This effectiveness is conditioned by organic changes within the vessel wall which may decrease its capacity to constrict or dilate and also by whether or not the vasoconstrictor influences are excessive. For example, the degree

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**Special needles and tubing were kindly supplied by Becton, Dickinson & Company, Rutherford, New Jersey.

of vasodilatation expected in markedly sclerotic vessels without excessive vasoconstrictor influences is much less than in an extremity containing normal vessels which have been thrown into a state of vasospasm by excessive vasoconstrictor impulses such as may be produced by an embolus lodging in a previously normal popliteal artery. The collateral circulation to an extremity is increased by sympathectomy by some as yet poorly understood mechanism. It is probable that the release of vasospasm is only a part of the explanation.

B. *Relief of Pain*

The mechanism which causes pain in such conditions as causalgia and post-traumatic neuralgia is not known.[2] However, this pain often occurs in the presence of other evidence of abnormal sympathetic activity such as vasomotor and sudomotor dysfunction. Various painful states of the extremities are markedly improved or eliminated following sympathectomy. In general, sympathectomy is more successful in relieving pain when associated with other evidence of increased sympathetic activity. It seems unlikely that this relief is due to interruption of afferent nerve fibers running through the sympathetic ganglia. An increase in blood supply to the part may explain the relief of pain in many instances. Actually, the mechanism of the therapeutic effect of sympathectomy on the various painful states remains obscure.

C. *Cessation of Sweating*

Sweating in the denervated area stops. Sweat glands are innervated by fibers from the sympathetic nervous system and interrupting this pathway eliminates the stimulus necessary to their functioning. With cessation of sweating, a potent cooling mechanism is lost, resulting in a warmer extremity.

A sympathectomized lower extremity will be free of the effect of vasoconstrictor impulses and the collateral circulation will be improved. Many painful states, particularly those associated with abnormal sympathetic activity will be relieved either entirely or partially. Sweating will be absent, resulting in a dry and warmer foot. Whenever one or several of these effects of sympathectomy are needed, either a temporary or a permanent interruption of the sympathetic pathway should be considered.

The indications for lumbar sympathectomy may be grouped according to the effect most needed. Frequently there is need for more than one of the effects, as in a patient with arterial insufficiency associated with pain, but usually the need for one effect is greater than for another. Therefore, such a grouping of the indications, though frequentiy overlapping, may be useful.

### A. Improvement in Circulation

1. *Occlusive arterial diseases.* This probably constitutes the largest group in which sympathectomy is indicated. Various types of such conditions are considered separately.

a. *Thrombo-angiitis Obliterans.* In the early stages of this disease there is a greater element of vasospasm which further diminishes the blood supply to the extremity. In the later stages there is less vasospasm, but even then the increase in collateral circulation which follows sympathectomy often is sufficient to justify the operation. Grimson[3] feels that the improvement following sympathectomy in these patients as well as those with arteriosclerotic vascular occlusion is related to the increase of the temperature of the extremity, to a slight improvement of circulation, and to the elimination of the constant fluctuations of tone ordinarily induced by the vasomotor nerves.

Practically all patients with this disease would benefit to some extent from sympathectomy, but operation is not indicated in every case. If the disease is mild and the patient becomes asymptomatic on nonoperative treatment consisting chiefly of abstinence from tobacco, good local foot care, and avoidance of undue trauma (cold, excessive exercise, etc.), sympathectomy need not be carried out. On the other hand, if, in spite of good conservative management, the symptoms and signs of arterial insufficiency remain and particularly if they progress, the sympathetic chain should be removed.

In evaluating the progress of Buerger's Disease, the presence of intermittent claudication, the appearance of the skin of the foot and toes and the pulsations in the popliteal, dorsalis pedis, and posterior tibial arteries are important. If claudication is brought on by progressively shorter distances of walking, if the skin becomes more atrophic and if a previously present pulsation becomes absent or diminished, the disease is becoming more severe. Oscillometric indices, skin temperature readings and plethysmographic determinations are of importance primarily to the investigator, but are not essential for following such a patient intelligently.

In the late stages of Buerger's disease, even though the amount of vasospasm of the main arteries may be insignificant, sufficient improvement in collateral circulation results from sympathectomy to justify the operation in many patients. Although there is gangrene present in a portion of the extremity and an amputation at some level is unavoidable, a more distal level of amputation may be possible with sympathectomy; and, furthermore, the need for future amputation may be delayed.

The results to be expected from sympathectomy are often predictable from a paravertebral sympathetic procaine block. This should be done routinely in any patient for whom a sympathectomy is being contemplated. A single procaine block may not allow an accurate evaluation. When there is significant vasospasm with other evidence of sympathetic overactivity a single block will give marked evidence of the improvement likely to follow sympathectomy. However, in other instances, where improvement in arterial blood supply after sympathectomy will depend largely on an improved collateral circulation rather than release of vasospasm of the large arteries, a single block in such patients often fails to give an accurate evaluation. We have used a continuous block in such patients for as long as 10 days, and feel that a more accurate evaluation of what might be expected from a sympathectomy is possible in this manner.

b. *Peripheral Vascular Sclerosis*

Vasoconstrictor impulses usually have less importance in patients with arteriosclerosis of the main vessels of the extremities than in other types of obliterative arterial diseases. Even here, however, some patients benefit markedly from sympathectomy. My associates and I do not feel that a lumbar sympathectomy should be done routinely in these patients. On the contrary, we feel that, in general, certain factors contraindicate sympathectomy. Sympathectomy should not be seriously considered in patients over 65 to 70 years of age, or in patients with severe generalized arteriosclerosis with definite cerebral, cardiac or renal involvement. Also, if massive gangrene is present or if severe infection is present in the gangrenous or adjacent tissues, sympathectomy instead of the indicated amputation would be unnecessarily dangerous to the life of the patient.[4] The present evidence has not convinced us that sympathectomy is ever indicated in an asymptomatic extremity even though the arteriosclerosis is marked. Excluding the above groups of patients, a smaller group remains in whom sympathectomy should be considered.

In the absence of gangrene, but in the presence of marked symptoms of neuritic pains, intermittent claudication or pain at rest, a paravertebral sympathetic block with procaine is indicated. If there is relief of symptoms especially when accompanied by an appreciable rise in the temperature of the skin of the foot, sympathectomy is worthy of a trial. When the results of a single block are equivocal, the decision regarding the advisability of sympathectomy is more difficult. A continuous block maintained over a period of a few days to a week or 10 days allows a better preoperative test of the effect of sympathectomy. The increased exercise tolerance,

the benefit of night pains and the occasional delayed rise in skin temperature may be observed, indicating that sympathectomy would benefit the patient.

In the presence of gangrene, there is more disagreement regarding the advisability of sympathectomy. The decision depends upon several factors: the age and general condition of the patient; the extent of gangrene; the presence or absence of infection; and the degree of occlusion of the main arteries of the lower extremity.

In old patients with marked generalized arteriosclerosis, or younger patients with marked cardiac changes, renal insufficiency or cerebral changes, our experience has been very disappointing. It is granted that sympathectomy may aid the healing of the amputation stump and may occasionally allow a lower-leg amputation in lieu of a thigh amputation. Although sympathectomy is in itself a relatively minor procedure with little risk to the patient, it does add one operative procedure (and sometimes more if a lower-leg amputation is attempted) and one anesthesia which sometimes prolongs the hospitalization sufficiently to allow the patient to die of the generalized disease. Whereas, if the inevitable loss of the extremity is accepted and an early thigh amputation is carried out, the patient is less apt to develop difficulties so prone to occur in this group of patients when hospitalized for any cause. Life is more important to these individuals than the possibility of saving an extra 8 or 10 inches of one extremity. Therefore, in this type of patient our usual policy is to proceed with a primary thigh amputation without preliminary sympathetic surgery or local amputations. Occasionally, when there is evidence of sufficient collateral circulation to allow prompt healing, a below-the-knee amputation is done in this group.

If gangrene is extensive and involves most of the foot, and there is no palpable pulsation in the popliteal artery, we recommend an early supracondyiar amputation. There are a few exceptions. In a relatively young patient with little evidence of generalized disease affecting other systems and without infection a continuous sympathetic block may be used. If the response is favorable either immediately or a few days after such a block, a below-the-knee amputation may be carried out along with lumbar sympathectomy. This attempt is more justified when the opposite extremity has already been lost.

In those individuals of the younger age group without serious generalized disease and in whom the gangrene is limited to one or two toes or a small area of the foot, we feel justified in attempting to save as much of the extremity as possible. If a sympathetic block gives prompt vasodilatation, a sympathectomy is performed either

a few days preceding or at the same time as a local amputation. Unless a prompt vasodilatation occurs with the single block, a continuous block is instituted. A delayed favorable response to the continuous block is occasionally seen which was not evident with a single block. In such cases sympathectomy is indicated and may be carried out prior to or at the same time as a local toe or below-the-knee amputation. An added theoretical advantage of the continuous block is in regard to the rare case which after sympathectomy instead of showing improvement, shows evidence of a decreased blood supply to the tissues resulting in rapid progression of gangrene, as reported by Atlas[6] and Freeman.[7] Fortunately, we have not yet observed this phenomenon, but if it occurred during a continuous block, the block could simply be stopped and the sympathetic impulses would return. The progression of gangrene may or may not be checked depending upon the amount of thrombosis already present and the importance of the A-V Shunts which may have been opened by the block.

Where there has been progression of the gangrene in spite of a continuous block, as more frequently happens, sympathectomy is probably not justified. Following a few bad results in attempting below-the-knee amputation in the absence of good response to blocking the sympathetic chain we now resort to supracondylar amputation in this group. Unless there is a favorable response to either a single or a prolonged block, sympathectomy probably has little to offer the patient.

When there is clinically-evident infection in the necrotic or adjacent tissues, particularly if it is spreading, there exists a real threat to life. Probably the safest procedure is to amputate without delay. However, this is frequently seen in diabetic patients with good popliteal artery pulsations. In such patients, a short period of conservative treatment with antibiotics and continuous sympathetic block is felt justified. We feel that conservative management of the infection can more safely be attempted in the absence of sympathetic impulses. In this way the early crucial phases may be managed with the possible advantages of sympathetic blockage without the risk during this phase of a surgical sympathectomy. Local amputation of a toe, a preliminary ankle disarticulation or the drainage of an abscess may be carried out with the block being maintained. If needed, sympathectomy may be done a few days later at a more desirable time.

c. *Acute Arterial Occlusion*

Chief among the sudden occlusions of the major arteries of the lower extremity are occlusion due to embolus and trauma.

In the treatment of occlusion due to embolus many factors are given consideration. The question of removal of the embolus, and the use of anticoagulants are beyond the scope of this report. There is a marked element of vasospasm superimposed upon the obstruction caused by the embolus itself. In a young individual, or in an elderly person with young arteries, this vasospasm is more marked than in those with marked sclerosis of the vessel walls. However, it is likely that a significant portion of the arterial insufficiency, even in those with marked sclerosis, is due to associated vasospasm.

A single paravertebral sympathetic block is usually sufficient to determine the degree of vasospasm and to evaluate the effect of a sympathectomy. In most patients, if seen too late for embolectomy, a lumbar sympathectomy is indicated if there is moderate to marked arterial insufficiency and if there is marked improvement with temporary sympathetic block. If the degree of circulatory embarrassment is slight and the resulting symptoms are questionable, a continuous sympathetic block may be used to give added information regarding the role of the sympathetic impulses. In 1 patient a block maintained over a period of one week was sufficient to not only relieve her symptoms during that time, but this improvement was maintained, making a sympathectomy unnecessary. In other patients the prolonged block gave a better test of the effect to be expected from sympathectomy, but the improvement was not maintained after discontinuing the block. In these, lumbar sympathectomy was indicated.

In patients seen early enough for embolectomy it is probable that a continuous block initiated immediately and continued for a period of 10 days would obviate the necessity of either daily single blocks or a sympathectomy. In such instances, where the normal arterial flow can be re-established, the need for obliteration of the sympathetic impulses may be limited to the early phases, and a permanent interruption should not be necessary.

Sudden arterial occlusion due to trauma occurs usually as a result of external violence which also produces injury to structures adjacent to the injured vessel. Not only is the main artery damaged, but there is also destruction of part or most of the collateral circulation. In addition to re-establishing the arterial blood flow through the main artery by direct suture, end to end anastomosis, or by graft, interruption of the sympathetic impulses is usually quite beneficial. Sympathectomy is indicated when the damage is great or when the continuity of the blood flow cannot be re-established. However, the primary injury is occasionally such that an added operative procedure is unwise during the early, most critical phase. In these in-

stances, repeated single blocks or a continuous sympathetic block accomplishes the purpose without the added risk of operation at that time. It is our impression that a continuous block is often more effective than repeated single blocks.

Acute arterial thrombosis may occur in an extremity with marked arteriosclerosis. This may take place about a large atheromatous plaque either *in situ* or where it lodges more distally. This presents a graver prognosis from the standpoint of the affected extremity than the large embolus in more normal arteries. There is less vasospasm associated with this type of occlusion and practically no chance of operative removal of the thrombus. The problem is similar, however, and a sympathetic block, preferably continuous, should be carried out. If improvement occurs sufficient to maintain viability of the extremity, a lumbar sympathectomy is indicated. If the extremity is obviously non-viable an amputation should be promptly performed at a sufficiently high level to assure primary healing. A sympathectomy is not indicated, since in this type of patient there are usually marked generalized arteriosclerotic changes and the possible benefits of sympathectomy would be more than offset by its risk to life.

d. *Arteriovenous Fistula and Aneurysm*

In many instances a lumbar sympathectomy is indicated either prior to or at the same time as operation done to cure the aneurysm or fistula. Prior to surgical exposure of the arterial lesion, one cannot be certain whether or not the arterial channel can be maintained; therefore, it is wise to have the patient prepared for possible ligation of the artery. Unless there is good evidence that the collateral circulation is adequate, a sympathectomy is indicated. One can assume that the collateral circulation is adequate if the nutrition of the limb is good and there are no palpable pulses distal to the aneurysm or fistula. Continued good circulation in the limb during prolonged (20 to 30 minutes) occlusion of the involved arterial segment also indicates an adequate collateral circulation. The reactive hyperemia test introduced by Matas and refined by Schumacker[8] is probably the most reliable test for collateral circulation. Briefly this test consists of draining the limb of blood by elevation and manual pressure and interrupting the blood flow by a blood pressure cuff applied distal to the arterial lesion and inflated to a pressure of 220 mm. of mercury. The limb is then placed in a horizontal position and after four minutes, the aneurysm or fistula is occluded by digital pressure. One minute later the blood pressure cuff is released suddenly, but the digital compression is continued for two minutes more. If complete hyperemia results within this two minutes the collateral circulation is felt to be adequate.

We agree with Shumacker[9] that, "It seems advisable to apply the procedure (sympathectomy) in cases where there is evidence of poor collateral circulation, in which the lesions are of sufficient duration to have ordinarily produced good collateral circulation and in which simple means of improving the collateral circulation have shown no effect during a short period of trial."

Occasionally, however, an aneurysm is first seen after it has already ruptured. In such instances an accurate preoperative testing for adequate collateral circulation cannot be carried out, and after ligation and excision of the aneurysm, an obvious ischemia of the foot may be present. If so, interruption of sympathetic impulses is indicated. In very ill patients in whom even a sympathectomy may be hazardous, a continuous block may be used for several days until the patient's general condition can be improved sufficiently to allow a sympathectomy to be carried out with relative safety. This continuous block may also furnish evidence that a sympathectomy will not maintain the viability of the extremity, in which case the limb may be amputated promptly, and a needless sympathectomy may be avoided.

e. *Raynaud's Disease*

Raynaud's disease is extremely rare in the lower extremities, but when present in severe form it is an indication for lumbar sympathectomy.

Mild degrees of Reynaud's phenomenon are more common, but the condition is usually so mild that avoidance of cold, the use of proper clothing and the usual foot care suffice to relieve the patient's discomfort. Sympathectomy is rarely required.

2. *Venous System Disease.* The results of sympathectomy for diseases of the veins are variable and the difficulty in selecting patients for this operation is great. Certainly one cannot hope to make incompetent venous valves competent or to materially decrease the amount of fibrosis already present in the soft tissues by sympathectomy. Therefore, one should not expect those symptoms and signs, caused directly by incompetent veins or by old fibrosis about the vessel and other soft tissues, to be materially affected. However, there is often an associated element of increased sympathetic activity. Excessive sweating, cool or cold feet, diminished arterial pulsation and varying degrees of pain are common accompaniments of these diseases. Certainly it is true that acute inflammation in or around a vein is commonly associated with arterial vasospasm. Particularly when there is such evidence of increased sympathetic activity, sympathectomy can be expected to lead to improvement. Chief among the conditions in this group are postphlebitic sequellae including recurrent deep thrombophlebitis.

a. *Postphlebitic Ulcer*

Lumbar sympathectomy certainly should not be used routinely for postphlebitic ulceration. There are a few optimistic reports and many pessimistic reports on the results of sympathectomy for this condition.

There are several factors of much greater importance in successfully treating these extremities than the influence of the sympathetic impulses. Local care of the ulcer with good supportive bandaging is most important. Incompetent saphenous veins should be surgically treated. When the deep veins are patent and incompetent these too should be interrupted.[10,11] Not infrequently the ulcer should be excised with its fibrotic surrounding tissue and the area covered by a split-thickness skin graft. The long-term results of any or all of the above measures are frequently disappointing. The additional benefit of sympathectomy in increasing the arterial blood supply to the tissues about the ulcer site may in some cases make the difference between an area which will stay healed and an area which will intermittently develop ulceration. When ulceration does recur after sympathectomy its healing is often more rapid than before.

In those patients with persistent or recurrent ulceration who have had adequate care of their veins, particularly if there is considerable pain in and about the ulceration and if there are signs of increased sympathetic activity, an evaluation of the sympathetic influence is indicated. If a sympathetic block produces an increase in skin temperature, especially in the area adjacent to the ulcer, and a significant improvement in the pain, a lumbar sympathectomy may be expected to cause improvement.

b. *Postphlebitic Edema*

Results of sympathectomy in patients with postphlebitic edema have been disappointing. In those whose edema is of short duration some benefit has been observed. It is likely, however, that nonoperative treatment consisting chiefly of adequate compression bandaging and limitation of activities would be sufficient to care for most of these patients. Especially in the presence of considerable pain and vasospasm, a continuous block may give evidence over a period of several days that stopping the sympathetic impulses would be of considerable help in caring for the extremity.

Accurate measurements of the diameter at several levels of such extremities before and after walking a given distance, both without and with a sympathetic block, may give valuable information. If there is a greater decrease in edema with sympathetic block, a sympathectomy is warranted.[12]

c. *Recurrent Deep Thrombophlebitis*

The use of procaine sympathetic blocks for treating some acute cases of thrombophlebitis is generally accepted. The resulting release of vasospasm and diminution of pain makes the patient much more comfortable and probably leads to more rapid subsidence of the inflammation. A prolonged temporary block as is possible with intermittent injection of procaine through an indwelling tube has many advantages over repeated single blocks for this condition.

Repeatedly recurrent bouts of deep thrombophlebitis is sufficiently favorably influenced by sympathectomy to warrant its serious consideration in some patients.[13] Particularly when associated with vasospasm, pain, cool, damp feet, and epidermophytosis, can good results be expected. The cessation of sweating makes the treatment of epidermophytosis less troublesome and probably results in less ascending infection from this source. When recurrent thrombophlebitis does occur after sympathectomy we have observed it to be less severe and of shorter duration.

## B. Relief of Pain

There are many conditions of the extremities which have varying degrees of associated pain. In many instances pain is the most prominent factor, but in others although pain may be present and bothersome, its associated cause is more important. The value of sympathectomy for relieving pain is well established in some conditions, while in others it may or may not give sufficient relief to indicate its use. Even in patients with similar primary difficulties associated with pain, some will have relief of pain by sympathectomy, while others will not. Because of this inconsistency of results a test by sympathetic block is indicated prior to operation. Procaine blocks are indicated also by the fact that occasionally a permanent cure results from the temporary blocking alone. The indwelling tube used with continuous block is ideal for evaluating the patient's response to procaine versus placebo, since the variable of different sites of injection is eliminated.

1. *Post-Traumatic Neuralgias*

The dramatic response of a patient with agonizing and constant burning pain and hyperthesia of major causalgia to sympathectomy is one of the most gratifying experiences in surgery. Experience with this method of treatment has been chiefly in association with war injuries. Civilian injuries also may develop minor or major degrees of this type of pain.

Early treatment of the major causalgias is of utmost importance in order to decrease the resulting disability of the affected extremity

and to alleviate the mental strain which is so commonly associated. Physiotherapy is often urgently needed but cannot be adequately carried out because of the pain. After alleviating the causalgia appropriate physiotherapy can be given, thus avoiding the permanent disability which otherwise may result.

A procaine block of the sympathetic ganglia should be carried out first. If the pain is relieved but only for the duration of the block, and then recurs in its original severity, sympathectomy is indicated. If the relief lasts longer than the duration of the block, and particularly if, on recurrence, the pain is of decreased severity, further blocks may be indicated in the hope that operation may be unnecessary. Shumacker[14] reported that 21 out of 83 patients with causalgia received satisfactory permanent alleviation of their symptoms from one or more procaine injections. We and others have had less success by injection alone. At any rate if the pain persists after one or a series of blocks, a sympathectomy is indicated to produce permanent relief. Minor degrees of causalgia and the less severe paresthesias rather frequently follow injuries of the extremities especially when a peripheral nerve is only partially injured. These cases likewise are benefited by sympathectomy. In them also preliminary blocking of the sympathetic ganglia with procaine is necessary. This blocking on one or several occasions suffices to relieve the pain and paresthesia permanently in some instances. More often it serves simply as a test for evaluating the results of sympathectomy.

2. *Post-Traumatic Dystrophy*

Following trauma to an extremity, usually of relatively minor degree, there occasionally occurs a painful condition of the ankle associated with marked osteoporosis of the bones of the ankle. This is usually associated with a cold, damp foot exhibiting evidence of overabundance of sympathetic activity. Usually lumbar sympathectomy is required. It should be performed relatively early before permanent damage to the ankle has resulted and is highly successful in most patients. A preliminary sympathetic block is desirable in order to evaluate the effect of the proposed sympathectomy.

3. *Pain Associated with Peripheral Vascular Diseases*

The amount of pain present in various disorders of the peripheral vascular systems varies markedly. In some patients with pronounced arterial insufficiency there is little or no pain, while in others with relatively slight arterial insufficiency the pain may be severe. The mechanism whereby pain is produced is uncertain, but many will be relieved by sympathectomy.

Among the specific types of pain considered under this general heading are: (1) pain associated with marked arteriosclerosis

("night pain," constant burning pain, and neuritic pain); (2) intermittent claudication; (3) "neuritic" pain associated with diabetes; (4) pain associated with extremities previously affected by frostbite, trench foot or immersion foot; and, (5) pain associated with postphlebitic sequelae.

In none of these conditions is sympathectomy a sure cure. However, some patients in each of the above categories respond very favorably to sympathectomy. In some cases sympathectomy is indicated regardless of its effect on pain; in others little can be expected except its effect on pain.

In evaluating the amount of pain relief to be expected from sympathectomy, a procaine block is indispensable. As a rule single blocks are quite satisfactory. We have seen no striking response in pain relief after several days of continuous block that was not evident also with a single block, although a better evaluation of the "night pains" can be obtained with a continuous block.

The persistent burning pain in the feet and legs associated with marked obliterative arterial disease has been particularly resistant to sympathectomy. Peripheral nerve crushing is more effective in these cases, and occasionally amputation must be resorted to.

Intermittent claudication seldom is relieved completely, but following sympathectomy most patients are able to walk a significantly greater distance before the claudication occurs. In some instances the claudication is replaced by a sense of extreme fatigue without actual pain.

The pain resulting from frostbite, trench foot[15,16] and immersion foot may be of two types, a hyperesthesia of the foot and an aching of the ankle and foot arches. When associated with vasospasm[16] benefit may be expected from sympathectomy. In most cases the result of sympathectomy is accurately predicted by procaine block.

The pain of erythromelalgia and acrocyanosis is said to be relieved by sympathectomy.

*Miscellaneous Types of Pain*

Painful neuroma and phantom-limb pain occasionally respond favorably to sympathectomy. Rarely is the relief complete, however, and, unless there is good response to sympathetic block, sympathectomy is not indicated. Good results may occasionally be obtained in localized pain secondary to inoperable or metastatic carcinoma.

### C. Cessation of Sweating

Sweating can always be eliminated by sympathectomy, but this

need in itself very rarely necessitates operation. Very frequently, however, this is a valuable adjuvant to the other benefits desired of sympathectomy. The severe postphlebitic sequelae, the post-traumatic neuralgias and the chronic disabilities following frostbite, immersion foot or trench foot are particularly prone to be associated with a cold, clammy, wet extremity. This type of foot provides ideal conditions for epidermophytosis, which furnishes an avenue of entry to secondary invaders. After sympathectomy, the foot is dry and warmer. It is warmer not only as a result of vasodilatation but also because the cooling effect of evaporating sweat is lost. Such a foot is less apt to become infected. That is an important consideration in most peripheral vascular diseases.

Although cessation of sweating is often a valuable and desired side effect of the operation hyperhidrosis alone rarely indicates sympathectomy.

## Summary

Indications and contraindications of lumbar sympathectomy are presented from the standpoint of the effects of the operation on the lower extremity. The use of a continuous paravertebral sympathetic procaine block aids in the selection of patients for operation and occasionally makes operation unnecessary.

A. Circulation is improved following sympathectomy. Most patients with thrombo-angiitis obliterans are benefited by sympathectomy, but operation is specifically indicated only in those patients whose signs and symptoms persist or progress in spite of adequate conservative treatment.

Only a small percentage of patients with arteriosclerotic peripheral vascular disease should have a lumbar sympathectomy. In general, this operation is contraindicated in patients over 65 to 70 years of age; in those with marked cardiac, renal or cerebral pathology; in those with massive gangrene; and in those who have severe infection in a gangrenous extremity. In younger individuals without the above mentioned contraindications, sympathectomy is often indicated and frequently gives gratifying results. A continuous block enables one to more accurately predict the result of sympathectomy.

In sudden arterial occlusion it is urgent that the sympathetic impulses be blocked. If the effect is required only temporarily, repeated single blocks or a continuous block may suffice; if permanent interruption is required, a sympathectomy is performed.

Lumbar sympathectomy is indicated in many patients with arteriovenous fistula or aneurysm in the lower extremity as a means of improving collateral circulation. If the collateral circulation is inade-

quate after the lesion has been present for three to six months, then in most instances sympathectomy should be performed prior to attacking the local lesion.

Raynaud's disease of the lower extremity responds well to sympathectomy.

Postphlebitic sequelae occasionally are improved by sympathectomy. Very careful selection of patients for operation is essential. In general those exhibiting marked evidence of sympathetic overactivity are more likely to benefit.

B. Many painful states of the extremity are improved by sympathectomy. Causalgia and other post-traumatic neuralgias, Sudek's painful osteoporosis, and various types of pain associated with peripheral vascular disease are sufficiently favorably influenced by sympathectomy to justify its serious consideration. As a rule, the results of sympathectomy are accurately predicted by a single or continuous sympathetic block. Particularly when pain is associated with other evidence of sympathetic overactivity are the results of sympathectomy likely to be good.

C. Hyperhidrosis of the feet may rarely be so bothersome that a lumbar sympathectomy is indicated to eliminate sweating. Frequently, however, the cessation of sweating that results from sympathectomy enhances the benefits of the operation when it is performed primarily to relieve pain or to improve the circulation.

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# FORWARD SURGERY OF THE SEVERELY WOUNDED

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THE medical profession of the world is always gravely concerned with war. In the history of warfare no sizable group of American surgeons ever had such a vast experience in the surgical care of severely wounded casualties as did the members of the 2nd Auxiliary Surgical Group. This experience was gained in two active theaters of operations: the North African, later to become the Mediterranean and the European with participation in 11 campaigns in Africa, Sicily, Italy, France, and Germany. The work to be reported is that of members of this Group. I had no actual participation in the operative surgery. It was my good fortune to be associated with this Group as its Commanding Officer. Full credit is due to its members for their extraordinarily fine surgical achievement. The excellent papers by many of its members and others detail the methods of management of various types of war wounds.[1-61] As chief surgical consultant of Natousa and Matousa, Dr. Edward D. Churchill directed our surgical efforts and his inspiring leadership was the guide to the surgical pursuits of this organization in its three years of overseas experience. This presentation is a brief abstract of the surgical experiences of the 2nd Auxiliary Surgical Group as recorded in the report "Forward Surgery of the Severely Wounded" submitted to the Surgeon General, U. S. Army in September 1945.

Forward surgery of the severely wounded pertains to the management of those casualties whose injuries are of such a nature that they cannot be safely evacuated further to the rear than the division boundary and require immediate surgery. Churchill's description of these casualties places them in two categories: First, those requiring the correction of profound physiological disturbances which immediately endanger life, and second, those requiring the arrest or the prevention of the complications of infection that if allowed to develop or progress may endanger life or lead to grave disability. The initial surgical management of battle casualties suffering from the above types of wounds constitutes the principal basis of this discussion.

The facilities for caring for such casualties is of interest. In the vast majority of instances tent hospitals were utilized. Platoons of

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field hospitals were employed and surgical teams from the Auxiliary Surgical Group were charged with the surgical management. The small hospital staff was responsible for the supplies, messing, housekeeping, and nursing care. This arrangement proved highly satisfactory, permitting mobility of the surgical teams. This hospital became known as a First Priority Surgical Hospital and was set up

**Fig. 1. First Priority Surgical Hospital in foreground. Division Clearing Station to right.**

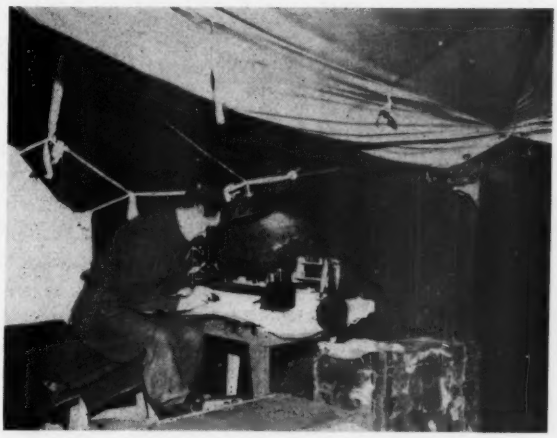

**Fig. 2. Laboratory in First Priority Surgical Hospital.**

adjacent to the division clearing station. At the division clearing station triage based on the urgency of the wound and condition of the casualty was accomplished. Approximately 10 per cent of the casualties reaching the clearing station were non-transportables and taken to the priority hospital often by hand litter carriage (figs. 1-6).

The simple but fundamental needs for the performance of good surgery are: (Churchill)

1. Experienced surgeons, anesthetists, and operating room personnel.
2. Simple x-ray facilities.
3. Simple but adequate operating room equipment.
4. Lighting and water supply.
5. Reasonable accommodation under shelter.
6. Good nursing.
7. Facilities to retain patients 10 days.

It is submitted that the proper utilization of these facilities led to the accomplishment of unprecedented surgical feats in abdominal, thoracic, and extremity war wounds.

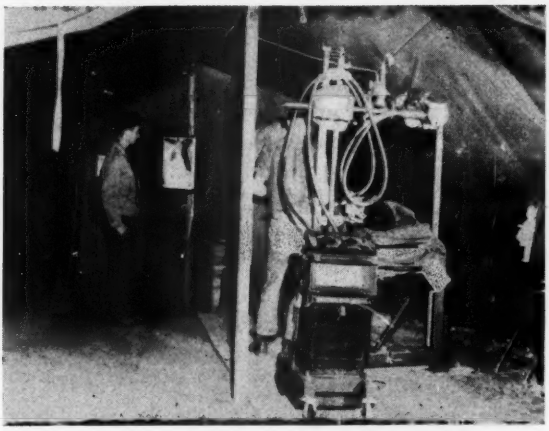

Fig. 3. X-ray facilities in First Priority Surgical Hospital.

Traumatic shock in war wounded furnished excellent opportunities for the study of theoretical considerations of this phenomenon and were thoroughly evaluated by the Board for the Study of the Severely Wounded in the Mediterranean theater during 1944 and 1945. In the management of such conditions emphasis is placed upon certain facts of practical significance. It is generally agreed that the most important factor is the loss of whole blood as the pathogenesis of the peripheral circulatory failure which follows injury. From an experience in the management of intra-abdominal injuries in approximately 3500 battle casualties, considerations of shock became of paramount importance. This figure is approximately two-thirds of all abdominal injuries recorded in the A.E.F. of World War I. From this experience 957 patients suffering from

perforating wounds of a hollow viscus were studied and data pertaining to the shock therapy employed were analyzed. These data are somewhat more applicable to the poor risk casualty. A classification of shock based principally upon the blood pressure values provides a practical means of assessment, appreciating that blood pressure decline may not occur early and that the severity of the shock is apt to be greater than indicated. Four groupings of casualties in relation to initial hospital blood pressure determinations

Fig. 4. Improvised scrub sink in First Priority Surgical Hospital.

Fig. 5. Patient in First Priority Surgical Hospital.

aided in defining the degree of shock. The relative amounts of replacement therapy required to accomplish resuscitation increases in almost direct proportion to the degree of shock (tables I and II). An evaluation of the role of peritonitis in the production of shock in abdominal wounds was difficult. The degree of peritoneal contamination is often great and the time interval from injury to surgery considerable. Experience repeatedly demonstrated that severe peritoneal contamination demanded prompt surgical intervention even though associated with marked blood loss.

TABLE I

(2nd Auxiliary Surgical Group)

*Blood Pressure in Determining Degree of Shock*

| | *Shock* | *Systolic BP* |
|---|---|---|
| Gp. I | Incipient or No Shock | 100-+ |
| Gp. II | Moderate | 70-100 |
| Gp. III | Severe | 40-70 |
| Gp. IV | Profound | 0-40 |

TABLE II

957 Battle Casualties
*Abdominal Wounds with Perforation of Hollow Viscus*
(2nd Auxiliary Surgical Group)

| Adm. Systolic | Replacement Therapy Preoperative and During Surgery | | Mortality Rate |
|---|---|---|---|
| | cc. | | |
| | Blood | Plasma | |
| 0-40 | 3362 | 1024 | 66.4% |
| 41-70 | 2549 | 1958 | 50.4% |
| 71-100 | 2036 | 863 | 38.% |
| 100+ | 1581 | 670 | 19.% |

The deleterious effect of the passage of time on the battle casualty is universally recognized. Hemorrhage, peritoneal contamination, and disturbances of physiology become more serious the longer they remain uncorrected. The average time lag for abdominal casualties from injury to surgery was 10.1 hours. Factors influencing the length of the time interval included terrain, tactical situation, climate, evacuation facilities, and distance. A heavy patient load in

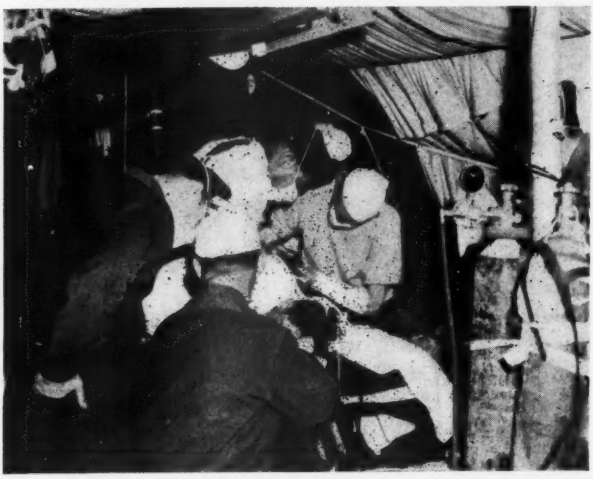

Fig. 6. Operation in progress in First Priority Surgical Hospital.

the receiving hospital, "D" Day invasions, and paratroop landings increased the time lag. The comparison of data for the two years, 1944 through 1945, doubtless reflects several factors which include increased experience, improved transport facilities, variation in ter-

rain, and probably more than anything else a greater appreciation on the part of the surgeon of the desirability to commence operation earlier on abdominal injuries (table III).

TABLE III

*Comparison of Time Lag 1944-1945*

| | *1944* | *1945* |
|---|---|---|
| Injury to Surgery | 11.3 hours | 8.9 hours |
| Injury to Admission | 6.9 | 5.6 |
| Admission to Surgery | 4.5 | 3.4 |

The mortality rates in relation to time lag are dependent upon many factors. An analysis of these data took on an added significance when considered in relation to the severity of the wound. Wolff termed this the "multiplicity factor" to serve as an index to the severity of the wound. In general, the patients operated upon with a shorter time interval after admission had a lower mortality. The more seriously wounded required a longer period of resuscitation treatment but the futility of delaying surgery in an effort to "stabilize" or maintain a blood pressure of 100 mm. Hg. or more systolic in those patients suffering from continuing hemorrhage or peritoneal contamination was recognized by the experienced.

The observation that the farther forward surgical treatment was initiated, the higher the over-all mortality is not a paradox. The reduction of the initial time lag by forward movement of surgical facilities brought more of the gravely wounded to the operating table. The death rate for the total number of casualties treated, therefore, rose because in some the wound was lethal. However, the mortality rate fell by the initiation of early surgery in those whose wounds were not inevitably fatal, but which would have become so with the passage of time. This emphasis on time lag between injury and initial surgery is equally essential in other phases of war surgery and the reduction by days and weeks between initial and reparative surgery in World War II was a decisive factor in earlier recovery and return to military duty.

The "multiplicity factor" refers to the number of abdominal organs injured in a given patient as determined at operation, there being no selectivity of organs and combinations are limited to numerical incidence alone. The mortality rate ascends with each additional organ injured. This is true for abdominal wounds as a whole and for each particular viscus (figs. 7 and 8). It is realized that severe hemorrhage, extensive damage to a single viscus, prolonged interval between wounding and surgery, peritoneal contamination,

and associated injuries of extra abdominal structures produce discrepancies which affect the multiplicity factor when applied to individual cases, but for group analysis it has proved to be a valuable index for the assessment of the severity of abdominal wounds.

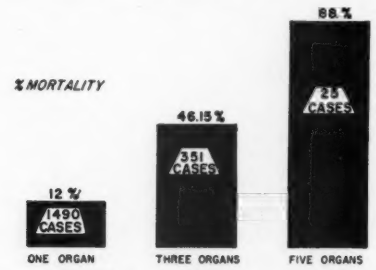


Fig. 7. Multiplicity factor in abdominal wounds, 2918 cases, 1944-1945 (2nd Auxiliary Surgical Group).

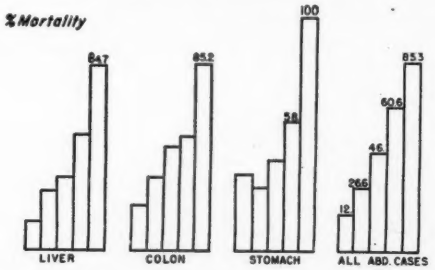


Fig. 8. Comparison of effects of multiplicity factor on mortality for each abdominal organ and total abdominal cases (3154) 1944-1945.

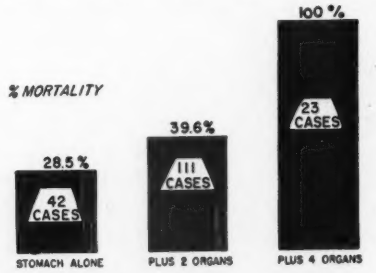


Fig. 9. Multiplicity factor in wounds of the stomach in 339 cases, 1944-1945 (2nd Auxiliary Surgical Group).

Certain factual data referable to the injuries of various abdominal organs are of interest. The experience gained from the management of 416 casualties suffering from wounds of the stomach revealed: (1) that such injuries occur frequently in warfare; (2) that 90 per cent had injury to other abdominal viscera; (3) that

they are one of the deadliest of abdominal lesions produced in warfare being exceeded in mortality only by wounds of the pancreas and duodenum; (4) that in 47 per cent the wounding agents traversed the pleural cavity; and (5) that 70 per cent of the deaths occurred between the start of surgery and the end of the second postoperative day. Almost invariably the reported cause of death was shock and peritonitis. The over-all mortality rate was 40.7 per cent; being 28.5 per cent if uncomplicated by other abdominal viscera injury and 42 per cent if complicated by injury to other abdominal organs. The significance of other abdominal viscera injury is emphasized (fig. 9 and table IV).

TABLE IV

Wounds of the Stomach
*Incidence and Mortality*

| No. Cases | Incidence | Mortality Rate |
|---|---|---|
| 416 | 13.2% | 40.7 |

Simple "purse string" suture of stomach wounds was condemned as it may fail to pick up the bleeding mucosa resulting in severe secondary hemorrhage. The perforations should be enlarged to permit layer suture of the stomach. Nasogastric suction through a Levin tube is indicated pre and postoperatively. The transdiaphragmatic operative incision is often preferable.

Duodenal injuries occur infrequently. There were 118 recorded, an incidence of 3.7 per cent of the abdominal injuries. Ninety-eight per cent were complicated by other abdominal injuries. The mortality rate was 57 per cent. Reflection of the right colon was the routine practice in all suspected duodenal injuries. The site of the intestinal anastomosis was drained in almost all instances and universally when complicated by pancreatic or liver wounds.

The small bowel exclusive of the duodenum is frequently injured in wounds of the abdomen. There were 1287 of the abdominal casualties or 36.4 per cent who suffered injuries of the small bowel, exclusive of the duodenum. The over-all mortality rate was 29.5 per cent. The reported incidence of small bowel wounds including the duodenum in the A.E.F. World War I was 22 per cent. The mortality rate was 80 per cent.

There is no criterion upon which to include or exclude preoperatively the possibility of injury to the small intestine in war wounds of the abdomen. The final diagnosis required direct observation at operation whenever signs and symptoms suggested an intra-abdom-

inal wound. There was no rigid dictum regarding the technic of repair of small bowel wounds. The sound surgical principles of gentle handling, use of fine suture materials, rapid careful assessment of all wounds, and the maximum protection against peritoneal contamination were practiced. Hemorrhage and injury to other viscera usually took precedence over the immediate operative repair of small bowel lesions. The practice followed was to perform the most expedient and conservative procedure compatible with secure repair and adequate preservation of the lumen. Very small perforations were usually "purse stringed," larger ones sutured transversely. Trimming of traumatized edges was conservative. It was sometimes convenient to convert two perforations into one, if they lay close together in the same vertical plane and suture the resultant defect. Transections were anastomosed with or without resection of short segments. Resection was obviously mandatory in many cases having macerated segments of bowel or if the bowel was avulsed from its mesentery. The management of multiple, adjacent perforations with normal tissue between presented a more difficult problem. Some surgeons performed individual suturing of the perforations and others resected the injured bowel segment if not of great length. The repair by suture only was accomplished in 56.8 per cent; by resection and anastomosis in 38.3 per cent, and anastomosis without resection in 4.8 per cent. The over-all mortality for all repairs by anastomosis 37.3 per cent and 23.3 per cent for suture repair. The end to end type of anastomosis was performed 10 times more often than the side to side method. The latter method being reserved for the management of cases requiring extensive resections. The extremes in length of bowel resected were two inches to 12 feet. In approximately 10 per cent of all cases more than one foot of bowel was resected. The majority of the surgeons employed an open two-layer end to end anastomosis. There is no place for the use of enterostomy in the treatment of small bowel injuries. Nasogastric suction drainage by means of a Levin tube was continued postoperatively from three to eight days. The removal of the tube coincided with the return of intestinal function such as audible peristalsis and passage of flatus. The Miller-Abbott tube was rarely employed. The incidence of postoperative complications was extremely low. Only 1.7 per cent developed mechanical obstruction and in only 1 per cent was there recorded evidence of small bowel leakage. There were 353 uncomplicated wounds of the small bowel representing 11 per cent of all abdominal injuries with a mortality rate of 13.9 per cent (table V).

It was found that the average time lag among patients dying with uncomplicated small bowel injuries was just twice that among those

who survived. It is inescapable that if patients with this type of injury can be properly operated upon within eight hours of injury, their chances of recovery are greatly enhanced.

TABLE V

*Incidence and Mortality of Small Intestine Injuries*
(Exclusive of the Duodenum)
1944-45

| No. Cases | Incidence | Mortality Rate Complicated | Uncomplicated | Average |
|---|---|---|---|---|
| 1168 | 37% | 36.3% | 13.9% | 29.5% |

Thirty-eight and four-tenths per cent of patients with intra-abdominal injuries had perforating or severe vascular wounds of the colon and rectum or both. Of these 1358 patients, 867 lived and 491 died, a mortality rate of 36.1 per cent. Uncomplicated injuries had a mortality rate of 23 per cent. Colon injuries complicated by other abdominal viscera wounds had a mortality rate of 40.8 per cent (table VI).

TABLE VI

*Colon and/or Rectal Injuries*

| Year | Patients | Deaths | Per Cent |
|---|---|---|---|
| 1943 | 136 | 58 | 42.6 |
| 1944 | 917 | 334 | 36.4 |
| 1945 | 305 | 99 | 32.4 |
| Total | 1358 | 491 | Average 36.1 |

Of 155 patients having perforative wounds of the rectum 64 had only involvement of the extraperitoneal rectum and a mortality rate of 14 per cent. Among 91 patients having rectal perforations complicated by other abdominal viscera injuries the mortality rate was 41.8 per cent. Rectal injuries comprised only 5 per cent of the colon and/or rectal wounds. Twenty-five per cent of the patients were under 21 years of age. Only 22 patients or approximately 2 per cent of the total were over 40 years of age. The average time lag from injury to operation was 10.9 hours and approximately three hours was required in preoperative resuscitation therapy. The increase in the mortality rate was proportionate to the number of organs involved (fig. 10). The mortality in patients with no shock was 10 per cent; in the presence of a moderate degree of shock the figure rose to 29 per cent, and to 69 per cent in the presence of severe shock. Above all else the state of shock was found to be the most

important syndrome concerned with the mortality of the severely wounded and the need for larger quantities of whole blood was again evidenced in the management of colon and rectal wounds (table VII). As experience increased, surgery was resorted to earlier, even if response to resuscitation was poor and vigorous resuscitation measures continued during and after surgery.

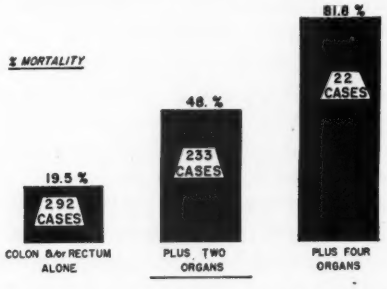


Fig. 10. Multiplicity factor in colon and rectal injuries, 1155 cases, 1944-1945 (2nd Auxiliary Surgical Group).

The principles of surgical management of colon and rectal injuries employed by the surgeons of the 2nd Auxiliary Surgical Group entailed the fundamentals of exteriorization of the injured bowel, if possible; proximal colostomy if exteriorization was not feasible to divert the fecal stream from distal wounds of the colon and rectum and adequate posterior drainage through the fascia propria for rectal wounds. The "loop" or the "spur" type of colostomy was generally used. The most difficult lesions to handle were those involving the terminal ileum and right colon. The lowest mortality rate achieved by any method of management was 51.7 per cent. The reflection of the peritoneum from retroperitoneal portions of the colon was necessary for thorough examination.

TABLE VII

*Blood Administered in Colon and Rectal Wounds*

| | No Patients | Blood cc. Average |
|---|---|---|
| Living | 721 | 1415 |
| Dead | 410 | 2950 |
| Plasma | 610 cc. for surviving patients. | |
| | 880 cc. for those who died. | |

The data presented on wounds of the liver are based on 829 patients treated for such injuries. This represented approximately 27 per cent of all casualties with intra-abdominal wounds. There

was an over-all mortality of 27.0 per cent and it is of interest that the rate was reduced from 34 per cent in 1944 to 15 per cent in 1945. World War I data reveal a mortality rate of 66.2 per cent for wounds of the liver. The effect of multiple organ involvement conforms to the experience in other abdominal injuries (fig. 11). Uncomplicated wounds involving only the liver had a mortality of 9.8 per cent. An interesting feature is noted in that 91 per cent of the patients, bleeding from the liver had ceased by the time abdominal exploration was accomplished. Experience indicated that the establishment of adequate external drainage of both bile and tissue products from the traumatized liver is of singular importance in the treatment of liver wounds. The dry gauze pack does not function efficiently as a drain and its use was early abandoned. Rarely were liver wounds sutured and apparently without regret for the practice was discontinued.

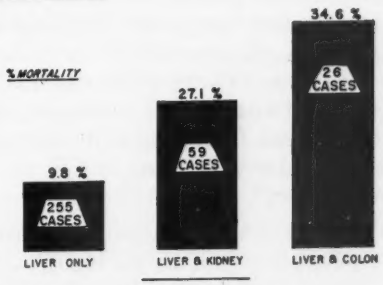


Fig. 11. Mortality of liver wounds plus other visceral wounds (2nd Auxiliary Surgical Group).

Drainage by means of a Penrose rubber tissue drain placed over the dome of the liver, at the site of the injury and in the sub-hepatic area making their exits through an adequate separate dependent incision was the preferred method of management. Removal of drains was begun in the fourth or fifth day and gradually continued until completed the tenth or twelfth postoperative day. To obviate the stretching of the rubber without the freeing of its gauze insert it became common practice to simply thread surgical tape through the rubber drain anchoring the tape to the rubber at intervals of three to four inches by means of a few silk sutures. Thus, when one withdraws the free outer end of the drain, the inner end is moved approximately the same distance. Shock accounted for approximately 50 per cent of the deaths despite early operation and energetic antishock therapy.

Injury to the spleen was encountered in approximately 10 per cent of all abdominal wounds. Three hundred and forty-one patients with splenic injuries were treated. The mortality for this

group was 24.9 per cent. If the spleen alone was injured, as it was in 100 cases, the mortality was only 12 per cent while in 241 patients there were other abdominal injuries and the rate rose to 30 per cent. It is interesting to note that in the A.E.F. of World War I only 49 instances of splenic injury are recorded, with a mortality rate of 63 per cent. Shock was the most common finding in injuries of the spleen but the absence of shock was by no means an indication that the spleen was unharmed. The treatment for wounds of the spleen is splenectomy and was carried out in 88 per cent. Occasionally a very slight fissure from which there was no active bleeding did not require splenectomy. Packing or suturing of splenic wounds was not practiced.

Wounds of the kidney occurred in 13.4 per cent of all abdominal injuries, an incidence twice that noted in World War I. Thirteen per cent were limited to the kidney and had a mortality rate of 16 per cent. Eighty-seven per cent were complicated by wounds of other abdominal organs, of these 40 per cent died. The over-all mortality was 36.3 per cent. Every effort was made to conserve the kidney. Damage to the renal vessels, extensive destruction of the parenchyma, or widespread fracturing with destruction of the renal blood supply necessitated nephrectomy in 120 of 427 patients suffering injury to the kidney.

The advances in thoracic surgery during the interval between the two World Wars were put to full use during the latter conflict. The full appreciation of the physiological disturbances of cardio-respiratory injuries and the constant aid of qualified anesthetists equipped with adequate apparatus enabled the surgeon to obtain splendid results. Experience indicated that about one-half of the casualties suffering from intrathoracic injuries alone could be safely evacuated from first priority hospitals to evacuation hospitals 5 to 20 miles to the rear. Of an experience in the management of 1364 casualties with severe intrathoracic injuries, exclusive of 903 thoraco-abdominal casualties, the mortality rate was 9.89 per cent. Among the 1112 patients in whom the thoracic injury was the major wound the mortality was 6.29 per cent while in 137 patients with severe associated wounds (exclusive of abdominal) the mortality rate was 33.58 per cent.

Hemoptysis, hemopneumothorax, "sucking" chest wound, roentgenographic evidence of pneumothorax, foreign bodies, evidence of dyspnea and cyanosis are the more common findings in thoracic injuries. Shock is quite variable and appears to depend basically on blood loss and/or mechanical disturbances of the cardio-respiratory system. Probably the major contributions in the care of thoracic casualties at first priority surgical hospitals was the correction of

cardio-respiratory imbalance. The removal of blood and/or air without air replacement from the pleural space, relief of pain by intercostal nerve block, tracheobronchial catheter aspiration, and closure of the thoracic wound are fundamental considerations in the restoration of cardio-respiratory balance. This last war offered conclusive proof that extensive procedures such as lobectomy or pneumonectomy are rarely, if ever, indicated in the initial surgery of thoracic wounds. Correction of blood loss by whole blood replacement and control of the bleeding site are again essentials of good surgical management. Caution is necessary in replacement therapy. A practical guide to blood loss is aided by noting the amount of blood removed by thoracentesis and the rapidity of its accumulation. Blood clots in the pleural cavity and the amount removed may be slight even in the presence of severe bleeding. Severe bleeding for lung parenchyma was seldom encountered.

The surgeon's principal concern at operation in forward hospitals is the restoration of a functioning lung, fully expanded against an intact or restored thoracic wall. Thoracotomy at this level was found to be indicated for: (1) possible thoraco-abdominal injuries, (2) large chest wall defects, and (3) various, but seldom encountered injuries, such as those involving the heart, esophagus, tracheal injury and continuing hemorrhage. The services of a competent anesthetist are absolutely necessary for the proper surgical care of thoracic wounds. The marked strides made in the care of thoracic injuries in base hospitals will not be discussed, save that such therapy practically eliminated the chronic empyemas and patients characteristically classified as "pulmonary cripples" seen in such large numbers among the thoracic casualties of World War I.

The missiles of war producing wounds have no regard for anatomical boundaries often perforating the diaphragm resulting in a combined injury of the pleural and peritoneal cavities. Personnel suffering from such wounds have been designated as thoraco-abdominal casualties. During 1943, 1944 and 1945, 903 such casualties were treated. Casualties, in whom the pleural cavity and peritoneum have been entered by separate missiles without injury to the diaphragm, are not included. The incidence of thoraco-abdominal wound with respect to all abdominal wounds was 25.5 per cent. In 837 the missiles entered the abdomen through the thorax against 66 which entered the chest through the abdomen.

The degree of shock based on clinical evaluation at time of admission when compared with percentage of fatalities, revealed a mortality rate of 5.5 per cent in those casualties without evidence of shock, whereas 60 per cent of those who arrived in severe clinical shock, died. Of principal importance in combating shock, and sav-

ing life in thoraco-abdominal wound, was early operative treatment. Temporizing and delay in bringing these patients to early operation as soon as replacement therapy was started, presumptive diagnosis established, and measures to combat cardio-respiratory imbalance performed was found to be detrimental. The preoperative introduction of a nasal stomach tube for aspiration of the gastric contents was a requirement. Control of respiration under endotracheal anesthesia, tracheo-bronchial aspiration of blood and bronchial secretions, closure of the chest and diaphragmatic wounds, control of hemorrhage and contamination are the essentials in the surgical management of these patients. Experience substantiated these principles by a steady reduction in the mortality (table VIII).

TABLE VIII

*Mortality Rate (903 Thoraco-Abdominal Wounds)*
(First Priority Surgical Hospital Only)
(2nd Auxiliary Surgical Group)

| | Total | 1943 | Jan.-June 1944 | July-Dec. 1944 | 1945 |
|---|---|---|---|---|---|
| Patients | 903 | 68 | 243 | 392 | 200 |
| Deaths | 247 | 25 | 84 | 98 | 40 |
| Mortality | (Average 27.3%) | 36.7% | 34.9% | 25.0% | 20% |

Methods of surgical approach were not predicated on any one as ideal for all patients. In general, where a thoracotomy and laparotomy were both contemplated, the chest procedure was performed first as it was found that the patients stood laparotomy better after the chest wall and diaphragm closed and the lung re-expanded. In 362 patients, or 30 per cent, with thoraco-abdominal wounds, the entire procedures were performed through the diaphragm.

Extremity injuries in war account for the greatest number of physical casualties. At the level of the First Priority Surgical Hospital the completion of traumatic amputations or the removal of mutilated extremities comprised the major problem in extremity injuries. The flapless guillotine amputation was the standard procedure and experience gave no reason for changing. The site of amputation was the lowest possible level of viability regardless of the vitality of the stump and traction on the stump was constantly maintained. The mortality rate for major amputations was 6.8 per cent.

The analysis was made of 1165 severely wounded patients who died. These data indicate the principal type of injury (table IX). The figure of 1.6 per cent dying in the shock ward is indicative of

superb achievement in resuscitation and early surgery. The exhaustive study of deaths in the 5th Army made by Snyder should be reviewed.

TABLE IX

*Deaths*
1165 Patients

| Injury | Dying in Shock Ward. No Surgery | Dying During Operation or Induction of Anesthesia | Dying 1-10 Days Postoperative |
|---|---|---|---|
| Abdominal 46%<br>Thoraco-Abdominal 20.4%<br>Extremity 16%<br>Thoracic 8.4%<br>Head, Neck, Spine and Maxillo-Facial 7.1%<br>Burns 7%<br>Blast 1.4% | 1.6% | 8.3% | 90.1% |

Sulfa drugs were always available and penicillin after June 1944. Efforts made to establish their beneficial effects by intraperitoneal administration at the time of operation were inconclusive. The beneficial effects of parenteral administration of penicillin is well established and its intraperitoneal administration at the time of operation in intra-abdominal injuries seems desirable.

No report of this nature could be complete without again emphasizing the superb achievements in the field of anesthesiology which did much to enable the accomplishment of unprecedented surgical results.

For the first time in the history of warfare, high emphasis was placed upon the surgery of the most severely wounded. Special purpose and equipped hospitals furnished with experienced young surgeons, anesthetists, nursing and operating room personnel were established as far forward as facilities permitted to care for the small group, approximately 10 per cent, of casualties who could not be safely transported further to the rear. The great efforts directed toward the postgraduate residency training in the hospitals of this

country were reflected in the highly competent surgeons and anesthetists who contributed so much to the surgical laurels of World War II. The management of specific organ injury may be briefly summarized. Wounds of the stomach and duodenum were sutured, wounds of the small bowel treated by suture or by resection and anastomosis, wounds of the colon exteriorized, wounds of the liver by subcostal drainage, and of the spleen by splenectomy. Wounds of the kidney were treated by nephrectomy, only when hemorrhage was persistent or the pelvis involved, otherwise drainage sufficed. Thoracic wounds called for correction of the cardio-respiratory imbalance; extensive excision of pulmonary parenchyma being unnecessary. The flapless guillotine amputation at the lowest possible level of viability was practiced and traction on the stump maintained. The concepts proved by this recent experience are equally applicable today. Further developments in chemotherapeutic agents such as streptokinase may aid in further reducing mortality and morbidity.[61] The surgical results are a matter of record with the over-all mortality of 23.9 per cent for intra-abdominal wounds, 10 per cent for severe thoracic wounds and 27 per cent for thoraco-abdominal injuries. The high level of performance of forward surgery as reflected in this experience by a representative group of America's finest young surgeons had such a tremendously favorable influence on the morale of our fighting forces that a repetition and further improvement will be demanded by Field Commanders. As in the past this challenge will be met by our medical profession.

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# A LONGSTANDING MISCONCEPTION ABOUT A PORTION OF THE MAJOR BILIARY DUCT*

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THE study of the liver and bile passages began in the dawn of time, with Babylonian and Assyrian priests meticulously describing the entrails of sacrificial animals. Momentous decisions based upon the arrangement of the viscera were handed down. The king of Babylon is said to have "looked into the liver," as present day Swamis gaze into a crystal ball. The Greeks, Romans and Egyptians in turn added their descriptions. Today the study goes on apace. Every month some *article* outlining a new concept of liver and biliary physiology, pathology or anatomy appears. Concerning a subject studied for so long, it is odd that misconceptions should still exist, but we have found this to be true regarding the part of the duct system herein described.

The portion of the extra-hepatic biliary duct system herein referred to begins at the junction of the right and left hepatic ducts and ends at the point where the common bile duct passes behind the duodenum. The cystic duct is disregarded for the purposes of this study.

The misconception concerning this part of the duct relates to the line followed by the duct as it goes toward the left in its course from above downward, and the angle this line makes with the midline or vertical axis of the body.

Every surgeon, preparing to invade some particular anatomical region, usually has a definite mental picture of that region. This mental picture began forming when he was a medical student dissecting in the anatomy laboratory and following the descriptions and illustrations in the anatomy guide. Later, as a practicing surgeon with no access to the anatomy laboratory, his mental visualization of anatomical relations now depends on a frequent review of the illustrations and descriptions in standard anatomical textbooks plus his own observations at the operating table. Since he was taught the accuracy of the anatomical illustrations as a medical student, he now relies upon this accuracy to guide him in difficult places.

As we all know, anatomical illustrations are made in a definite

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way. The part toward the top of the page is cephalad, and that at the bottom caudad, unless otherwise designated. On looking at an illustration of abdominal anatomy, for example, one knows automatically that a line drawn from the top of the page directly downward should be parallel to the midline of the portion of the body illustrated. Thus when we see a duct such as the one under consideration drawn in a line that is straight up and down the page we naturally, and correctly, assume that that is its correct anatomical position and we should expect, at operation, to find the duct approximately parallel to the midline of the body.

For a number of years it has become increasingly apparent to one of us (J.P.B.) that a serious discrepancy existed between our mental conception of the position of this duct under study, and its position as we have repeatedly observed it in the operating room. We have always dissected out the cystic duct and a portion of the common duct, as a routine part of cholecystectomy and other procedures involving these structures, and for a long time have felt that the angle made by the line of the duct and the midline of the body was very much greater *in our patients* than that shown in many illustrations reviewed. The conviction grew that the discrepancy was far greater than even generous variations would account for.

## Method and Material

Inasmuch as this supraduodenal section of the biliary duct is the portion most frequently injured during surgical procedures, and since its integrity is essential to life, a study of its actual course and position was deemed worthwhile. We undertook to determine, first, the average angle made by the line of the duct and the midline of the body as shown in various standard anatomy textbooks; second, the average angle as shown in postoperative cholangiograms; and third, to measure the angle in cadaver specimens in the anatomy laboratory.

*First:* Eleven illustrations (Plate 1) were chosen from standard anatomical textbooks,[1-9] and the angle was carefully measured. One showed an angle of 5°, four showed angles of 0° or less, and six showed angles ranging from 12° to 34°. The *average angle,* therefore, as shown by standard anatomical illustrations, was 14.3°.

It is of interest to note that in an early edition of Gray's Anatomy (Plate 2) a diagrammatic drawing showed a negative angle, while curiously enough a diagram made by Andre Vesalius in 1538[12] was much more representative of the true line of the duct. Neither of these are included in our figures.

20
DAVIS APP. ANAT. 1910
20
CALLANDER 1937
16
DEAVER SURG ANAT 1903
12
TOLDT 1948
CUNNINGHAM 1922 5TH ED.
GRAY 20TH ED
33
CUNNINGHAM MANUAL
SOBOTTA / MC MURRICH 1928

**Plate 1**

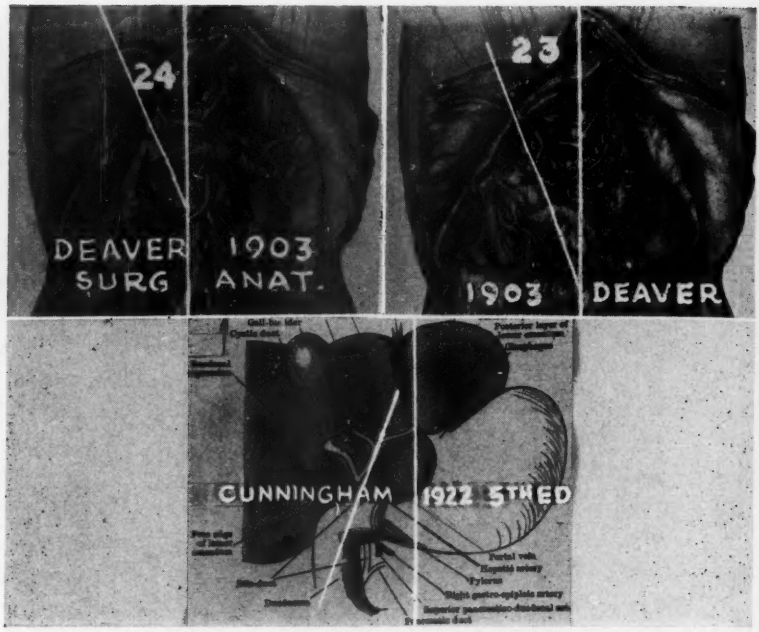


Plate 1 Continued

*Second:* A series of cholangiograms were chosen (Plate 3). Three of these were taken from the literature,[10,11] the rest being from local sources. These films were all made in the AP view with a T tube in the supraduodenal section of the biliary tract. A line paralleling the crosspiece of the T tube represents the line of that portion of the duct fairly accurately. A line drawn down or parallel to the vertebral column indicates the midline of the body. The angle

Plate 2

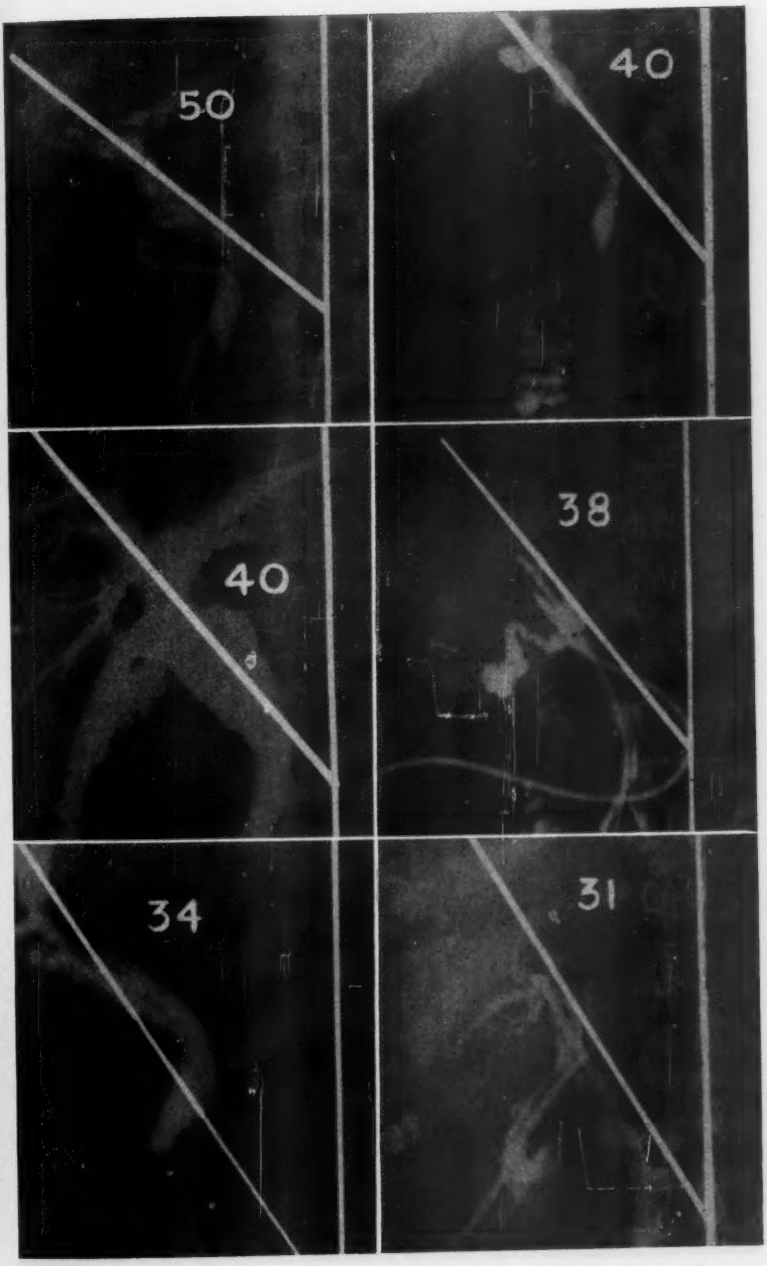


Plate 3

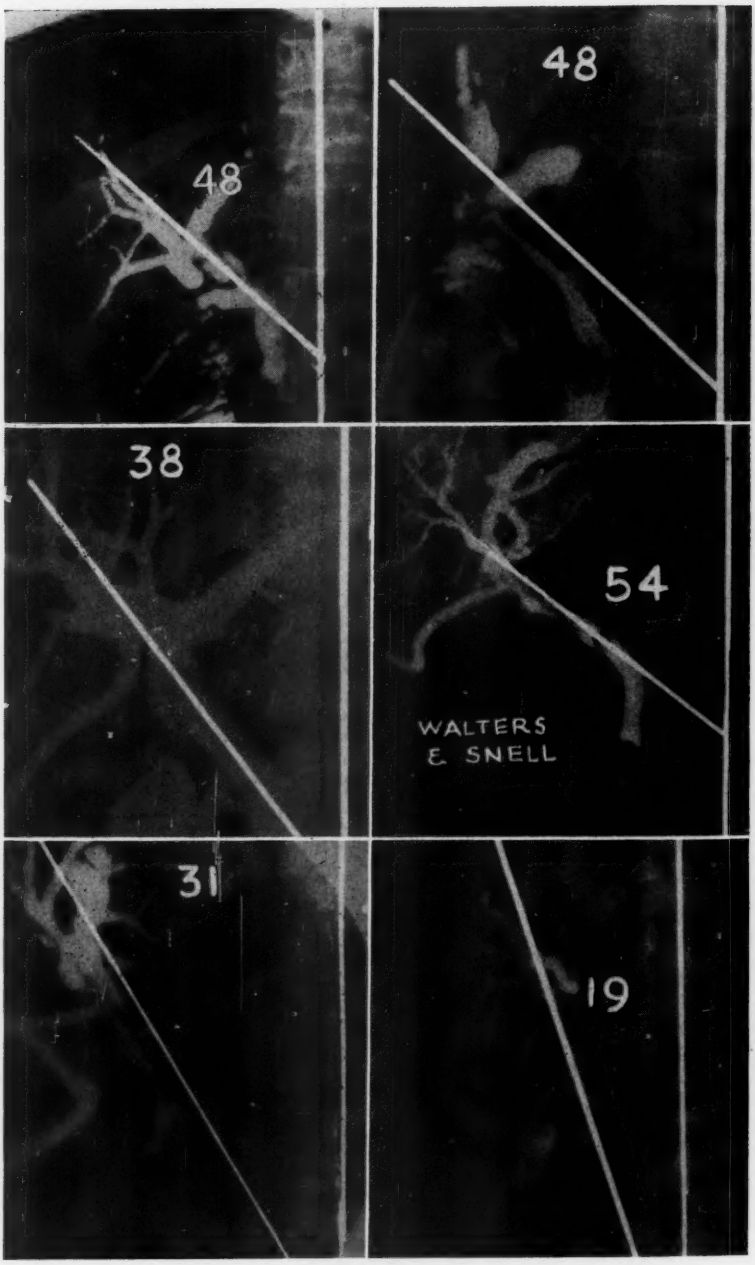


**Plate 3 Continued**

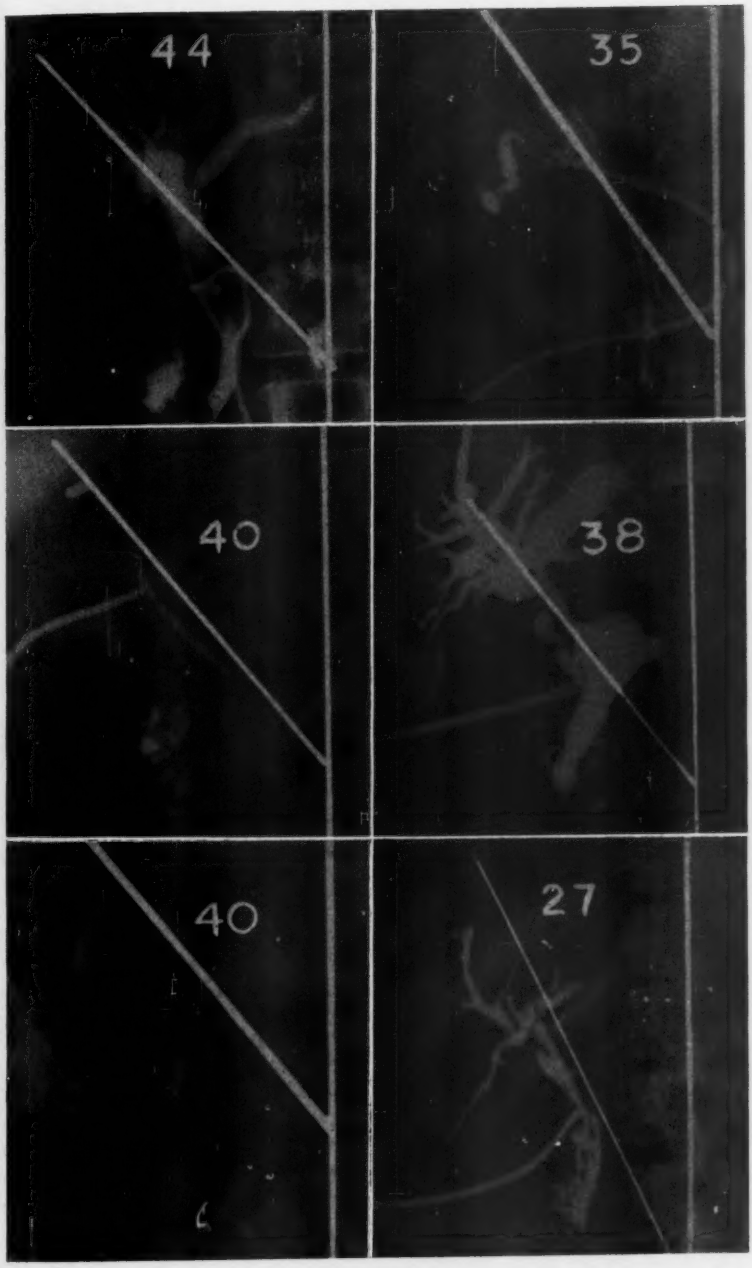


**Plate 3 Continued**

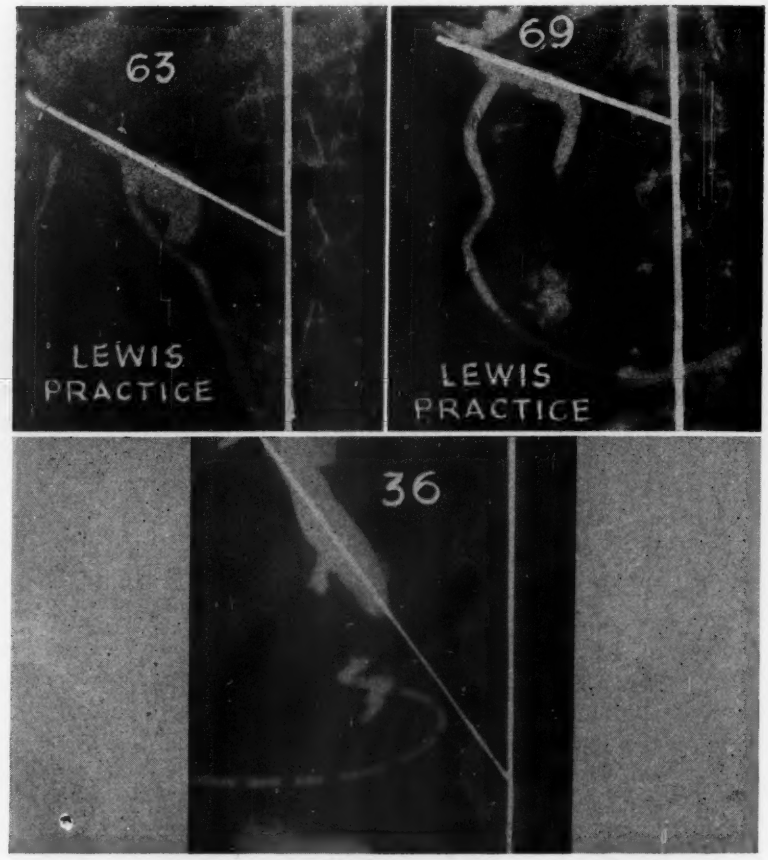


Plate 3 Continued

made by the intersection of these lines probably represents the reasonably true relationship of these structures. These 21 cholangiograms showed a range varying from 19° to 69°. The average angle for all the cholangiograms was 41°.

*Third:* Through the courtesy of the Anatomy Department of Baylor Medical College, Houston, a careful dissection of 17 cadavers was carried out by one of us (B.V.W.). As accurately as possible, the line of the duct was established and the angle with the midline measured (Plate 4). There was a range of from 20° to 78°. The average angle for the 17 dissections was 49°.

*Fourth:* Two autopsy specimens were studied as additional ma-

terial. In these an incision was made in the abdomen, and the common duct injected with a radio-opaque substance, the incision closed and x-rays taken. One had an angle of 37°, the other one of 38° (Plate 5), an average for the two of 37.5°.

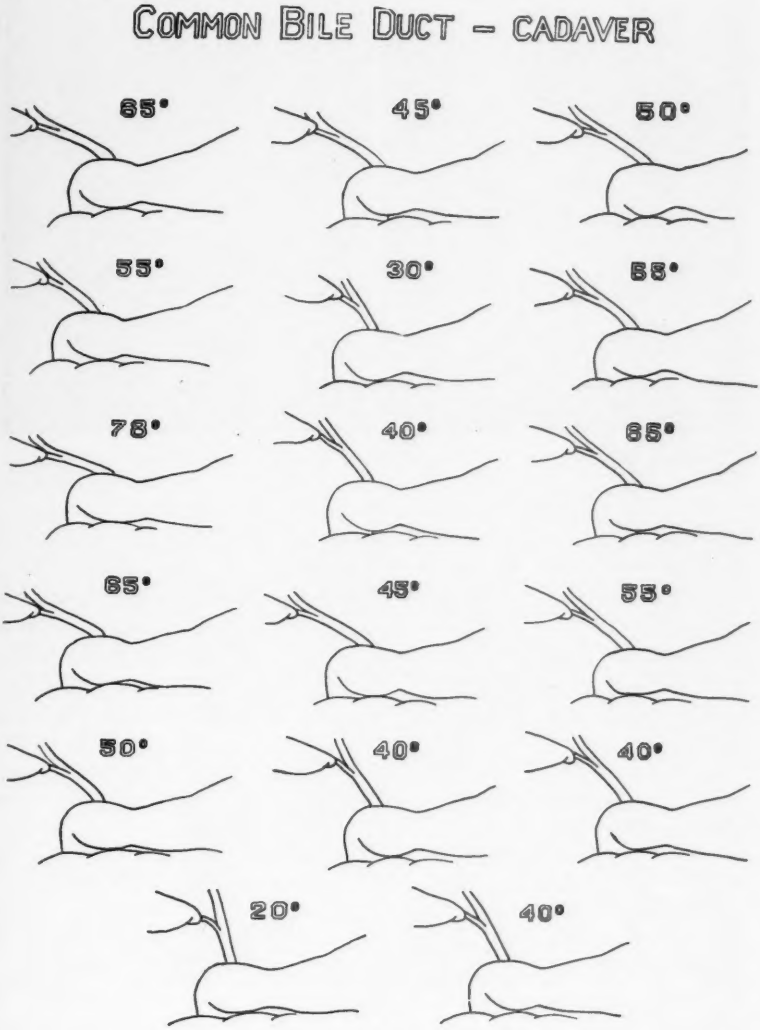


**Plate 4**

If we now take the over-all average of cholangiograms, cadaver dissections, and autopsies, we have an angle of 42.5°. This should

more nearly represent the course of the duct as it really is. It shows that the upper end of the duct is much more lateral than the lower end, but such is not the mental picture one obtains by reviewing the illustrations in standard anatomy textbooks.

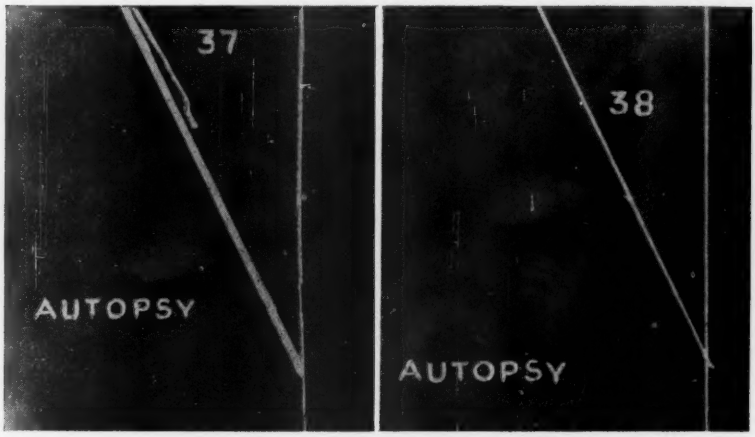


**Plate 5**

Since our mental picture of anatomical relationships is so dependent upon illustrations, it is absolutely essential that each and every such illustration be as accurate in every detail as possible. Where there may be wide variations it should be the aim of the illustrator to present at least a reasonable average picture. We do not feel this has been done with respect to the structure herein studied. To show how very confusing the status of this particular item is at present, some examples of extreme variations are shown (Plate 6) within the same book. Callander,[6] in one drawing, shows an angle of almost 0°, and in another an angle of 55°. Walters and Snell[10] show a negative angle in a diagram, and then one of 48° in an illustration.

## Conclusion

We believe that the average angle made by this duct and the midline is much more nearly 40° than 14°, as shown in many anatomical illustrations.

We are convinced that this misconception as to the actual line of the duct and therefore as to its real position must surely be a major contributory cause of many of the surgical accidents involving it. Surgeons of wide experience in this area have a more correct conception of it, but theirs is based on having dissected it out many times.

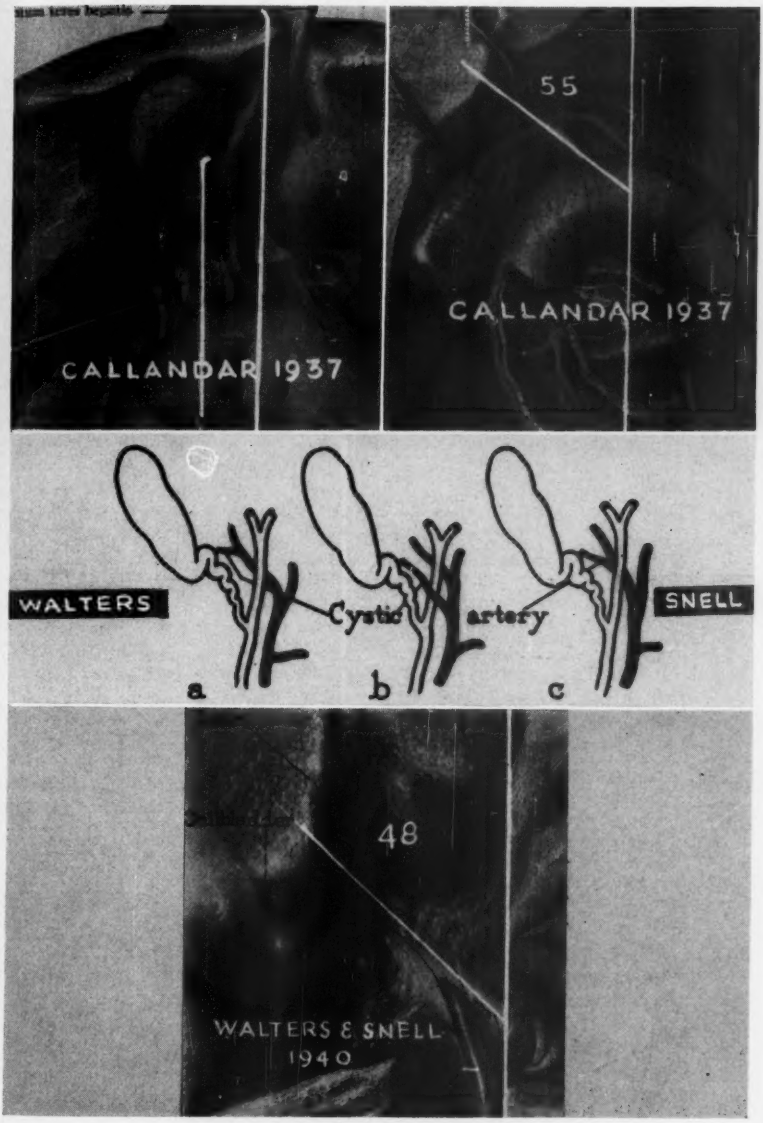


**Plate 6**

The occasional gallbladder operator, basing his mental picture largely upon the illustrations he has been reviewing, cannot and *does not* have an accurate picture of its location. He thinks of it as

being further toward the midline when as a matter of fact it is not, and damage to it results from this sense of false security.

We hope that these findings will be investigated by others, and the true average line of the duct eventually established. It is further hoped that if, as, and when this be accomplished the illustrators of the various anatomy textbooks, together with the publishers, will incorporate the change in future editions.

Credit for these illustrations from the standard anatomy textbooks is given as follows:

Plate 1.

Davis: Reproduced from Davis' "Applied Anatomy," 2nd ed., by Gwelym G. Davis, 1910. Published by permission of J. B. Lippincott, publishers.

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Plate 2.

Gray: Reproduced from "Gray's Anatomy," 8th English edition, 1878, published by Henry C. Lee Co., Philadelphia, Pa.

Plate 3.

All unidentified cholangiograms were provided by X-Ray men here, and a general acknowledgement is included.

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Plate 6.

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*Acknowledgment:* We are very grateful to Roentgenologists Palmer Wigby of St. Joseph's Infirmary, Curtis Burge of Methodist Hospital, Harry Fishbein of Jefferson Davis Hospital and Dr. John B. Rushing for their aid in collecting the cholangiograms.

Our sincerest thanks go also to Dr. John C. Haley, Professor of Anatomy, Baylor Medical College, Houston, for his very generous cooperation in making the cadaver material available and for helpful suggestions.

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# SPONTANEOUS RUPTURE OF THE SPLEEN

## Report of Three Cases

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TRAUMATIC rupture of the normal spleen is a fairly common occurrence. Traumatic rupture of the pathological spleen is also a frequent occurrence; and it may be produced by a trivial injury or by the force exerted during physiological acts, such as coughing, vomiting or defecation.

Spontaneous rupture of a normal spleen is so rare that many authors doubt such a possibility. However, Zuckerman and Jacobi[1] reviewed the literature up until 1937, and found 28 cases reported, 21 of which they accepted as authentic cases of spontaneous rupture of a normal spleen. They added 2 cases of their own. Babson and Morgan[2] collected 8 more cases from the literature and added 2 more cases.

It is not difficult to recognize a ruptured spleen when there has been a definite history of trauma and when it is accompanied by a hemorrhage sufficient to produce shock. There is considerable difficulty in recognizing the condition if the evidence of hemorrhage is slight, if the history of trauma is trivial and in the absence of trauma.

In obscure abdominal emergencies, rupture of the spleen must be considered in the diagnosis. This has been brought very forcibly to our attention by 3 such cases which we have had within the past year.

CASE 1. A 68 year old white male was first seen by us on April 30, 1949, complaining of severe pain in the left upper abdomen. Thirty years ago he had been treated for pulmonary tuberculosis in a sanatorium, and had recovered. He worked as a merchant, was very successful and raised a large family. His wife stated that he was always susceptible to chest colds and that he had a chronic cough which he attributed to smoking. About five months prior to this attack he developed a productive cough, fever and night sweats. In recent weeks he had noticed fever, pleuritic pains, loss of weight and strength. He raised about two ounces of a thick yellowish sputum which was positive for tubercle bacilli. His cough was extremely vigorous and strenuous, and his face became livid with each paroxysm.

On the day prior to admission, he rode a distance of 100 miles in an automobile from his home to a sanatorium in Asheville. On the morning of April

Presented during the Denver Assembly of The Southwestern Surgical Congress, Denver, Colo., Sept. 25-27, 1950.

30, 1949, he was suddenly seized with a severe pain in the left upper abdomen after a paroxysm of coughing. He was unable to cough or to take a deep breath without producing a sharp, lancinating pain in the upper abdomen. There was no nausea or vomiting, no history of chronic indigestion nor of similar previous episodes.

On physical examination, the patient was found to be an elderly, apprehensive white male in obvious distress. His skin was moist and clammy, and his lips were bluish in color. Examination of the chest showed limitation of expansion on the left side. The percussion note was slightly impaired over the upper lobe. The breath sounds were emphysematous in quality, but no rales were heard. The heart sounds were distant and weak; no murmurs were present. His blood pressure was 100/70; the pulse rate was 90 per min., the abdomen was tense and rigid, more so in the left upper quadrant. Active peristalsis was present. A rectal examination was negative.

Fig. 1. Roentgenogram of chest of Case 1, showing fibrocaseous tuberculosis with cavitation in left upper lobe.

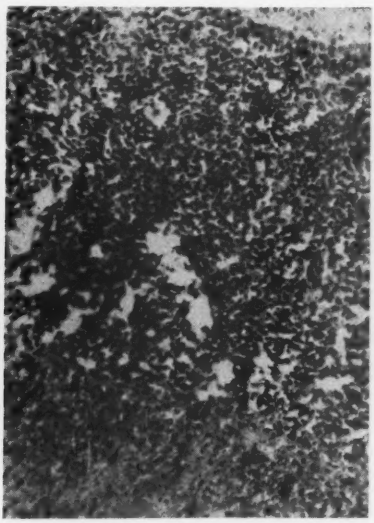

Fig. 2. Photomicrograph of spleen of Case 1. Normal splenic tissue is shown adjacent to a blood clot into which is growing fibroblasts. They indicate that the clot is at least several days old.

A roentgenogram of the chest (fig. 1) showed a heavy infiltration of the left apex, with cavitation and emphysema of the remaining lung tissue. His hemoglobin was 64 per cent; erythrocytes 3,320,000; leukocytes 24,600; with 81 per cent neutrophils, 10 per cent lymphocytes and 9 per cent monocytes.

An electrocardiogram and a consultation with a cardiologist ruled out coronary disease. He was watched closely during the night. The next day the tenderness and the rigidity of the abdomen were more marked, and a mass could be felt in the left upper quadrant. His hemoglobin had dropped to 61 per cent, erythrocytes to 2,320,000 and leukocytes had risen to 49,700. At

this time I suspected an intra-abdominal hemorrhage. An abdominal paracentesis was done, and old, dark blood was aspirated.

A stabilization of his blood pressure and pulse rate pointed to the probability that the bleeding had stopped; and we elected to wait until the patient's condition could be improved before operation.

A transfusion of 500 cc. of citrated blood was given on May 2, 3, and 4, 1949. On May 4, his abdomen was explored through a left rectus incision. A large perisplenic hematoma was found. This was removed, and the spleen rapidly delivered into the wound; its pedicle clamped, and the spleen removed. After ligating all vessels the peritoneal cavity was cleansed of blood and blood clots. A Penrose drain was inserted into the left subphrenic space, and the wound closed in layers. During the operation and immediately afterward he received two pints of citrated blood.

His convalescence was uneventful, and he was discharged to the sanatorium on May 18. This patient later developed an extension of his tuberculosis, and died from that cause on Dec. 20, 1949.

The pathological report was as follows:

*Gross:* The specimen consisted of a spleen with a large amount of blood clot. The spleen weighed 150 Gm. There was a blood clot attached to the capsule, and at one point the capsule appears to have been destroyed. The pulp is soft and red in color, and the Malpighian corpuscles are indistinct.

*Microscopically* (fig. 2), the splenic pulp is cellular and tends to obscure the Malpighian corpuscles. There are numerous plasma cells and a number of polymorphonuclear leucocytes and eosinophils. In some areas there is blood clot in intimate contact with the pulp, indicating a rupture. No evidence of tuberculosis was seen.

The pathologist considered this to be a normal spleen for a man of his age. He thought that there had been a subcapsular hemorrhage a short while previous to the later rupture and intra-abdominal hemorrhage.

After the patient had recovered he was closely questioned about any possibility of trauma, which he denied. His wife stated that he had stumbled and had fallen in the bedroom about three weeks before his admission, but apparently had not been hurt, and had made no complaint of pain at that time.

In our opinion this man had developed a subcapsular hematoma as a result of the previous fall, or more likely as a result of a severe paroxysm of coughing. Later, while in bed, the capsule ruptured after a severe coughing spell. This resulted in a severe hemorrhage from the spleen. We feel that this should be classified as a spontaneous rupture of a normal spleen, the result of force of muscular action during the physiological act of coughing.

CASE 2. This 61 year old man was suddenly seized with a severe upper abdominal pain while lying in bed reading on the evening of Oct. 22, 1949, about 10 p.m. There was no nausea or vomiting. He took two enemas which were effectual but did not relieve the pain. He induced vomiting without relief. He was seen by his physician at about 1:30 a.m. and again at 8:30 a.m., who found no abnormal physical signs. He gave him relief with opiates and advised hospitalization. The patient was admitted to St. Joseph's Hospital

at 5:30 p.m. on October 23. He walked in, and while he suffered severe pain, his general condition was good.

He had had an appendectomy years before, but otherwise his past history was irrelevant.

His hemoglobin was 108 per cent; erythrocytes 4,750,000, and leucocytes 15,700, with 78 per cent neutrophils, 20 per cent lymphocytes and 2 per cent monocytes. An x-ray examination of his chest and abdomen revealed no pathology in his chest, no collection of gas beneath the diaphragm, and no accumulation of gas suggestive of obstruction.

Physical examination revealed his heart and lungs to be normal; his blood pressure 140/90; pulse rate 98 per min. and respiration 22 per min. The abdomen was soft, and there was no tenderness or rigidity and no masses palpable; rectal examination was negative.

A tentative diagnosis of partial obstruction probably due to malignancy of the large bowel was made. He was given 2,000 cc. of 5 per cent dextrose in saline during the night. He was given relief by opiates. The next morning he looked ill. He continued to have pain. His abdomen had become moderately distended, and an enema was ineffectual. There was generalized tenderness and muscle spasm over the whole abdomen, but it was more marked in the left upper quadrant.

Surgical exploration was carried out under cyclopropane and ether anesthesia. The abdomen was opened through a right rectus incision. On opening the peritoneum, free blood escaped. Immediately the splenic area was explored. A large number of blood clots were evacuated; the spleen delivered into the wound and removed. All vessels were ligated. A large amount of free blood and blood clots were removed from the peritoneal cavity. No other pathology was found. A rubber tissue drain was inserted into the left subphrenic space, and brought out through a stab wound on the left side. The incision was closed in layers. During the operation the patient was given one pint of citrated blood by transfusion, and in the immediate postoperative period two more pints were given. His convalescence was rather prolonged due to ileus and asthmatic attacks. He recovered and has remained completely well except he has developed a ventral hernia.

The pathological report is as follows:

*Gross:* The specimen consists of a spleen which weighs 87 Gm. The capsule has been removed except for some on the medial surface. There are a few torn areas in the spleen, but there are no areas of hemorrhage into the pulp associated with these. However, on longitudinal section through the anterior portion, there are several masses of blood clot, which appear to be in enclosed spaces.

*Microscopically* (fig. 3), the spleen shows a number of circumscribed areas which contain blood. These areas show a wall that varies in thickness and show some hyalinized tissue. In a few areas there is a distinct endothelial cell lining. In other areas, it cannot be demonstrated. These blood spaces are scattered over a wide area, and none are completely adjacent to each other. The uninvolved portion of the spleen shows essentially normal pulp, in which there is possibly some increase in eosinophils. The Malpighian corpuscles are within normal limits as to size and appearance. Some of the nutrient arteries show hyalinization of the walls.

These vascular spaces are unquestionably the source of the intraperitoneal hemorrhage. There is no evidence of a tear of the spleen, as all of these observed grossly are not associated with hemorrhage into adjacent tissue. The exact point of hemorrhage cannot be ascertained.

*Diagnosis:* Hemangioma of the spleen.

This patient had a spontaneous hemorrhage from a pathological spleen while lying quietly in bed and without any antecedent trauma whatever.

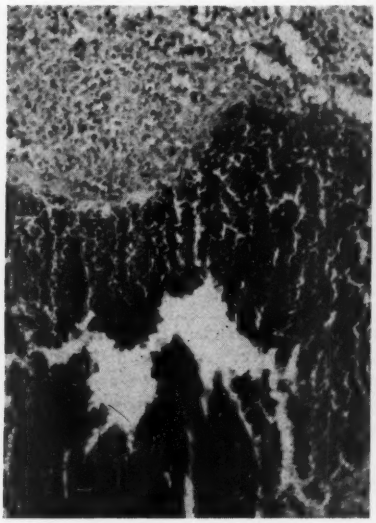

Fig. 3. Photomicrograph of spleen removed from Case 2, which shows normal splenic tissue and a large space filled with a blood clot.

Fig. 4. Photomicrograph of spleen removed from Case 3, revealing normal splenic tissue adjacent to the capsule.

CASE 3. This 27 year old man was admitted to St. Joseph's Hospital at 11 p.m. on May 24, 1950, complaining of severe epigastric pain which began that morning following a vomiting spell which was the result of drinking. About two hours after the onset, the pain radiated to the left shoulder and neck.

His past history is essentially negative except that he has had indigestion for several years, and has been treated for an ulcerated stomach. He admits being a frequent drinker of alcoholic beverages, but says he never gets drunk.

Physical examination revealed a well developed, slightly obese, adult male with an anxious facies. His heart and lungs were normal. Pulse rate 76; respiration 22, and blood pressure 120/80. The abdomen was moderately distended. There was marked tenderness and muscle spasm in the epigastrium and left upper quadrant. There was generalized abdominal tenderness.

Examination of his urine was negative, and the blood count showed a leucocytosis of 14,000, with 82 per cent neutrophils; 14 per cent lymphocytes and 4 per cent monocytes.

A diagnosis of a ruptured peptic ulcer was made, and a laparotomy done by my associate, Dr. Jesse P. Chapman, Jr. A right rectus incision was made, and on opening the peritoneum a large amount of blood was encountered. A ruptured spleen was found. The incision was enlarged by cutting transversely to the left. The spleen was then delivered and removed. The abdomen was emptied of blood. A drain was inserted into the subphrenic space, and the abdomen was closed in layers.

During the operation the patient received an intravenous infusion of 2,000 cc. of 5 per cent dextrose in saline, and after operation 1,000 cc. of citrated blood.

On examination of the spleen it appeared to be grossly normal, and a deep tear was present in the hilus. The patient's convalescence was stormy due to a bronchopneumonia on the left side, which was controlled by antibiotics. He also developed a purulent drainage, and later had to be readmitted for the drainage of a subphrenic abscess on July 16, 1950. He has made a complete recovery.

The pathological report is as follows:

*Gross:* The spleen weighed 190 Gm. On the under surface, especially in the region of the hilum, areas of hemorrhage were encountered. At one point this extends 5 cm. into the splenic substances.

Microscopically (fig. 4), the spleen shows a relatively thick capsule, and in this area of the section, considerable hemorrhage is present in the capsule layers and the adjacent connective tissue in the region of the hilum. In the splenic substance itself normal splenic follicles are encountered. In the pulp, areas of red blood cell infiltration are seen.

*Diagnosis:* Rupture of an apparently normal spleen.

In this patient we have a rupture of a normal spleen, the result of muscular action associated with vomiting.

*Discussion:* The symptoms of rupture of the spleen are: (1) Pain in the left upper quadrant, which may be referred to the left shoulder; (2) generalized abdominal pain frequently associated with nausea and vomiting; and (3) the signs and symptoms of internal hemorrhage and shock, the latter varying from no evidence of hemorrhage to signs of exsanguinating hemorrhage, shock and death.

In traumatic rupture of the spleen, there is usually a definite history of trauma. Fracture of the lower ribs on the left side is not uncommon and should make one think of the possibility of a ruptured spleen. In approximately 14 per cent of traumatic rupture of the spleen, the initial hemorrhage is slight; bleeding stops, and later a secondary hemorrhage occurs, with rapid development of shock and collapse. This may occur hours to days later, and the patient may have forgotten about the injury. Zabinski and Harkins[3] collected 177 such cases of delayed hemorrhage from a rupture of the spleen, and described it as a definite clinical entity.

In acute abdominal emergencies, spontaneous rupture of a pathological or a normal spleen must be considered in the differential diagnosis. Any other abdominal condition may be confused with a ruptured spleen, such as ruptured peptic ulcer, acute cholecystitis, acute pancreatitis, acute appendicitis with peritonitis, acute mesenteric thrombosis, acute intestinal obstruction, ruptured ectopic pregnancy or intraperitoneal hemorrhage from any other source.

A careful history and careful physical examination, plus indicated laboratory studies, should aid in establishing the correct diagnosis. Roentgen ray examination of the abdomen is said to be of help in the diagnosis of rupture of the spleen. A density in the left subphrenic space that displaces a stomach, which is often distended, is suggestive of a ruptured spleen.

We believe that abdominal paracentesis, using a large, blunt needle as suggested by Wright and Prigot[4] is the most useful procedure that can be used in establishing the diagnosis of intraperitoneal hemorrhage. We used this method in the first patient, and we have used it on occasion in other abdominal emergencies, and have found it to be a safe and practical procedure which should be used more often than it is.

The treatment of rupture of the spleen, no matter what the cause, is, first, to control shock by transfusion of plasma, serum albumin or whole blood, and, second, to remove the spleen. We do not believe that suture of a lacerated spleen is safe as there is great danger of secondary hemorrhage. Complete removal of the spleen is the proper surgical procedure. Access to a blood bank is of the greatest importance in saving lives in the presence of hemorrhage from any source. We hope that the day is not far distant when the smaller, isolated hospitals will have ready access to whole blood or blood derivatives through the blood bank program of the American Red Cross.

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# WATER AND ELECTROLYTE BALANCE OF THE POSTOPERATIVE PATIENT*

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In the past two decades increasing attention has been paid to preoperative and postoperative care of the surgical patient. Patients who have been well prepared have had their anemia corrected, have been well hydrated preoperatively, have had replacement of blood fluid and electrolytes lost at operation and who have had intelligent postoperative care, have a much greater chance of withstanding a shocking surgical procedure than those who have not been adequately prepared.

The postoperative care of surgical patients usually is not difficult if they are young, healthy, or have not undergone extensive operative procedures, as their adaptabilities are great and usually no difficulty ensues if they are undertreated or overtreated. In contrast, in the aged, malnourished, diseased, or those who have undergone extensive surgery, infinite attention must be given to every aspect of their care if we can expect a minimal morbidity and a low mortality.

The attention that must be given to preoperative care, postoperative complications and their treatment, replacement of blood loss, maintenance of nutrition, will not be discussed here; rather, we will concern ourselves only with fluid and electrolyte balance in the postoperative period.

Loss of body water in surgical patients occurs from (1) expired air (2) sweat (3) gastrointestinal discharges (4) wound drainage and (5) urine. The kidneys excrete only that water which remains after other losses have been satisfied. To insure adequate fluid intake one must supply the equivalent of the insensible losses, replace all losses from drainage routes and give enough for the kidneys to excrete their waste products.

Coller,[8,9] Mason and Zintel,[30] Wangensteen[45] and others[6] consider a urinary output of 1000 cc. daily to be satisfactory in the majority of surgical patients. Between 1000 cc. and 1500 cc. must be calculated for daily insensible loss, that loss of vaporization from the skin and lungs when there is no visible perspiration. The total of the above losses usually ranges from 2000 cc. to 3000 cc. per

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**Abridgment of thesis submitted to the Faculty of the Graduate School of the University of Pennsylvania in partial fulfillment of the requirements for the degree of M.S. in Surgery.

day. Additional amounts should be computed for those with fever, hyperthyroidism and visible perspiration. Losses from all drainage routes must be made up volume for volume.[19]

Since the kidneys excrete only the fluid excess after other needs have been satisfied, the urinary output and specific gravity are probably the most reliable indicators of adequate fluid intake.[30] One should chart and total this output every 12 hours for adequate fluid replacement.

All laboratory and chart findings should be correlated with intelligent observation of patients.

The electrolyte requirement, though no less important than their fluid needs is, as a rule, less easily calculable. This is especially true in patients who have a stormy convalescence;[8,10] those with profuse wound drainage; those who have myocardial decompensation[21] or diseased kidneys,[44] malnourished individuals;[14,26,30,34,38,40] those in whom there was depletion of electrolytes preoperatively and those in whom an overload of saline has been given postoperatively.[11,12,43] As stated by Moyer,[31] it is difficult by any standard laboratory method to place the electrolyte requirement of all surgical patients on an arithmetical basis.

Salt depletion or salt overload in seriously ill surgical patients is of grave consequence; thus, it is important in these patients that their electrolyte balance be kept near the optimal level.

The electrolytes sodium and chloride have two main body functions; the regulation of the acid base balance, and the distribution of body fluids by their influence on osmotic pressure.[2,7,22,27,28]

A depletion of sodium chloride is usually accompanied by water loss with resultant dehydration, oliguria, retention of nitrogen with acidosis.[2,7,16,17,33,35,36,37]

If saline in excess is given there is an increase in fluid and electrolytes in the extracellular space; there is hypertonicity of this fluid causing additional withdrawal of water from the intracellular compartment; therefore, an inordinate amount of water is retained in the tissue spaces.[12,46] This excess causes no severe harm in healthy individuals as their circulatory systems can rather easily tolerate the tissue edema until their kidneys excrete the excess salt and water. In the aged with some myocardial disease or decreased kidney function or in seriously ill patients, there is a resultant overload to the circulation with injurious brain, pulmonary and wound edema with delayed wound healing.

As shown by Coller,[11,12] and others,[30,31,32,42,44] it is inadvisable to inflict heavy loads of sodium chloride upon the early postoperative

patient. Coller[13] has shown that during the first 12 hours postoperatively there are only small quantities of urine produced. The degree and length of the oliguria is in proportion to the age and disease of the patient and the magnitude of the operation. He believes, in this period, the surgeon should make up only that fluid or blood lost at operation and what will be lost in the immediate six to eight hour postoperative period; that is, enough to keep the blood volume at its normal level. Other authors[4,18,31,32,41] have popularized hypotonic repair solutions for replacement of water and electrolytes.

Ravdin[34,40] has shown that in hypoproteinemic states with lowered serum proteins and decreased colloid osmotic pressure, it takes less salt solution than otherwise to produce edema and symptoms of sodium chloride excess, and that wound edema, particularly in intestinal anastomoses, remains long after it ordinarily would have subsided. Moyer[31] believes that the incidence of pulmonary complications is increased with salt overload postoperatively.

Since it is inadvisable to inflict heavy loads of salt on seriously ill patients and although they tolerate mild salt deficiency better than an excess, one desires to keep their electrolyte balance as near an optimal level as possible. How, then, is it possible to determine the electrolyte needs of surgical patients? A number of laboratory tests have been devised but all have fallen short as dependable guides to a greater or lesser extent.[45] Plasma proteins, hematocrit and carbon dioxide combining power values may be notably inaccurate in depleted states.[1,15,31,32] It has been shown by many workers[1,2,3,7,24,25,29,42,44] that plasma or blood chloride values are unreliable in both sodium chloride excess and in moderate depletion. In salt excess there is extracellular retention of the electrolytes rather than hyperchloremia.[12] In moderate salt depletion the blood and plasma chlorides are kept elevated at the expense of low tissue chlorides.[44]

It is believed by many workers[1,24,25,29,30,36,42,44] that the urinary excretion of sodium chloride is the most reliable indicator of body electrolyte balance. When the optimal level of body chlorides is decreased, the kidneys act to conserve these electrolytes by suppressing their excretion.[44] When an excess of salt is given, there is usually a marked increase in salt excretion until body electrolyte balance is reached.[5,30] Hayden,[24,25] Marriott[29] and others[33,36,42,44] believe that this test is the most satisfactory indicator for the amount of salt administration necessary preoperatively. Van Slyke,[44] Coller[13] and others[17,21,23,39] have warned that even this test, without thorough clinical appraisal, is not entirely reliable in certain body alterations and diseased states. Unless one is aware of oliguria and decreased salt output in the immediate postoperative period, this test may not

be reliable.[13] When the kidneys are diseased or injured by shock or severe dehydration, this test does not accurately reflect internal conditions.[17,44] With salt and water retention in those decompensated, and in hypoproteinemic states, the test may not show the true picture of salt excess.[14,21,34,38] With potassium depletion, advanced cirrhosis, peritonitis, large gastrointestinal losses, or endocrine dysfunction, there may be abnormal retention or loss of one of the ions.[23,39] Notwithstanding its limitations under the above conditions, it is believed by many that if correlated with clinical acumen, this test offers the most reliable information of electrolyte balance of routine laboratory methods.

## Analysis of Cases

In the present series, a number of postoperative patients have been studied and a correlation of the fluid intake, output, blood and urinary chlorides were observed during a three day period following operation. Controls were given oral fluids postoperatively; some were given 5 per cent glucose in water; some were given an overload of saline in the immediate postoperative period and there were those given fluids according to clinical appraisal who had more extensive operative procedures and who required gastric suction.

### GROUP I—ORAL FLUIDS

*Blood Chloride Levels*

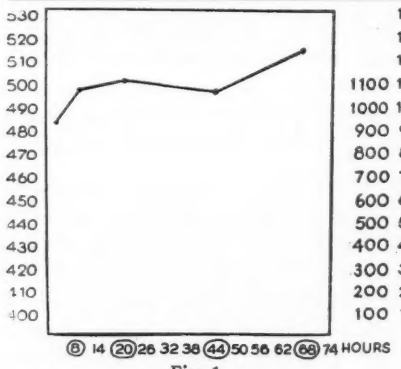


Fig. 1

*Urinary NACL and Urine Output*

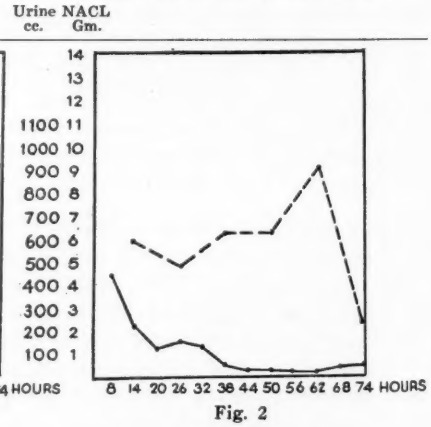


Fig. 2

Urine NACL ———
Urine Output — — —

Blood chloride levels were determined at the eighth, twentieth· forty-fourth and sixty-eighth hours. Quantitative urinary sodium chloride determinations were made at the eighth postoperative hour

and every six hours thereafter. All urinary chloride determinations were done by the method of Fantus.[20]

GROUP II—GLUCOSE AND WATER
(3000 cc. 5% G/NSS)

*Blood Chloride Levels*

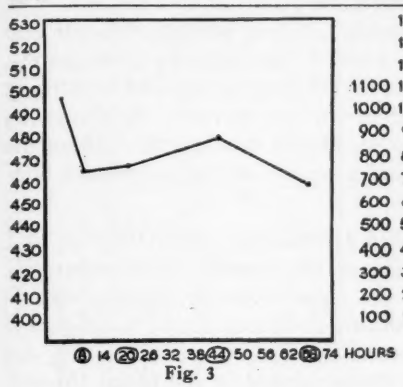


Fig. 3

*Urinary NACL and Urine Output*

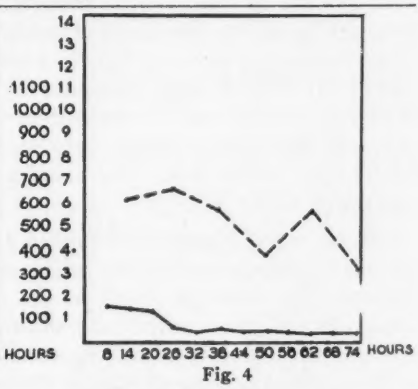


Fig. 4

Urine NACL ———
Urine Output .—.—.

GROUP III—OVERLOAD SALINE
(3000 cc. 5% G/NSS)

*Blood Chloride Levels*

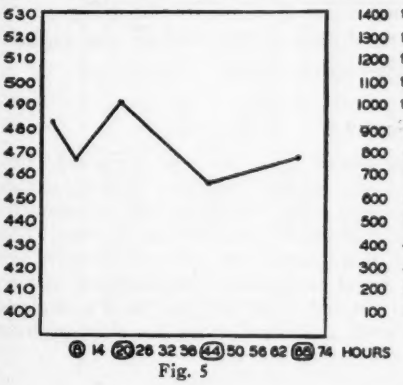


Fig. 5

*Urinary NACL and Urine Output*

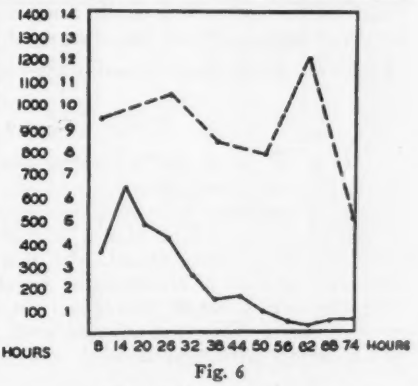


Fig. 6

Urine NACL ———
Urine Output .—.—.

There were 2 patients in Group 1 who were given only oral fluids postoperatively. The average level of blood chloride, urinary

sodium chloride and urine output are shown in figures 1 and 2. As revealed by these studies, the blood chloride levels show no fall whereas there was very little urinary sodium chloride being excreted after the thirtieth hour. Urine output at the fourteenth hour averaged 570 cc.

There were 4 patients in Group 2 who were given 3000 cc. 5 per cent glucose in water in the immediate postoperative period. The average levels of the blood chloride, urinary sodium chloride and urine output are shown in figures 3 and 4. As shown by these graphs, the blood chloride level remained within normal limits though there was some drop toward the end of the test period. As shown by figure 4, the urinary sodium chloride output was low throughout the latter part of the test. The urinary output at the fourteenth hour averaged only 620 cc.

There were 7 patients in Group 3 who were given 3000 cc. of 5 per cent glucose in normal saline in the immediate postoperative period. The average levels of the blood chloride, urinary sodium chloride and urine output are shown in figures 5 and 6. Figure 5 reveals that in spite of having received 27 Gm. of salt during this period, there was no elevation above normal in the blood chloride level. Figure 6 shows a marked increase in the output of urinary sodium chloride during the first 32 hours postoperatively.

Group 4, the results of which are shown in Table 1, consisted of elderly patients who had more extensive operative procedures and who required gastric suction for varying lengths of time. Urine output and urinary sodium chloride determinations were done every eight hours and every sixth hour thereafter. For the purpose of brevity, however, the results are shown at the end of the eighth, twentieth, forty-fourth and sixty-eighth hours.

### Group 4

Case 1. T. O. N. had a bleeding gastric ulcer that was oversewed. Preoperatively, the blood chloride level was normal but there was no sodium chloride in the urine. In spite of receiving saline throughout the postoperative period, a total of 32 Gm. of salt, he excreted but little during the test. This could be due to chronic shock with salt retention or to a preoperative salt depletion. In view of his history of loss of electrolytes from vomiting, and his adequate urinary output throughout the test, it is felt that he was depleted preoperatively. The blood chloride levels at the end of the test show evidence of a moderate salt deprivation.

Case 2. K. B., a patient who underwent a subtotal gastrectomy, shows negligible salt excretion throughout the test. This is accounted for by his receiving only 2.5 Gm. of salt until the forty-eighth hour, whereas there was a rather marked electrolyte loss from gastric suction, 15.5 Gm. The blood chloride levels show a moderate fall during the midperiod, but rose almost to

## TABLE I—EXTENSIVE OPERATIVE PROCEDURES REQUIRING GASTRIC SUCTION

| | | | *Preoperative* | | *Postoperative* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 8 Hours | | 20 Hours | | 44 Hours | | 68 Hours | |
| PATIENT | AGE | OPERATION<br>LENGTH OF OPERATION | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. |
| | | | Gm./L<br>O/L | Mg.%<br>467 | Total<br>Gm.<br>0 | Mg.%<br>477 | Total<br>Gm.<br>1.1 | Mg.%<br>444 | Total<br>Gm.<br>1.3 | Mg.%<br>456 | Total<br>Gm.<br>1.05 | Mg.%<br>428 |
| 1<br>T.O.N. | 62 | OVERSEWING BLEEDING GASTRIC ULCER<br>2 Hours | INTAKE IV→ | | 2000 cc. Blood<br>500 cc. 5% G/NSS | | 0<br>1000 cc. 5% G/NSS | | 1000 cc. G/NSS<br>1000 cc. 5% G/W | | 2000 cc. Amigen<br>1000 cc. 5% G/W<br>500 cc. G/NSS<br>500 cc. Blood | |
| | | | INTAKE ORAL→ | | 0 | | 0 | | 0 | | 0 | |
| | | | URINE OUTPUT→ | | 250 cc. | | 225 cc. | | 1650 cc. | | 1550 cc. | |
| | | | LEVINE TUBE→ | | 100 cc. | | 140 cc. | | 980 cc. | | 550 cc. | |
| PATIENT | AGE | OPERATION<br>LENGTH OF OPERATION | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. |
| | | | Gm./L<br>5/L | Mg.%<br>502 | Total<br>Gm.<br>.3 | Mg.%<br>444 | Total<br>Gm.<br>.1 | Mg.%<br>412 | Total<br>Gm.<br>0 | Mg.%<br>408 | Total<br>Gm.<br>.35 | Mg.%<br>444 |
| 2<br>K. B. | 50 | SUBTOTAL GASTRECTOMY<br>1½ Hours | INTAKE IV→ | | 1000 cc. 5% G/W<br>1000 cc. Blood | | 2000 cc. 5% G/W<br>0 | | 2000 cc. 5% G/W<br>1000 cc. Amigen | | 1000 cc. 5% G/W<br>1000 cc. 5% G/NSS<br>1000 cc. Amigen | |
| | | | INTAKE ORAL→ | | 240 cc. | | 0 | | 850 cc. | | 550 cc. | |
| | | | URINE OUTPUT→ | | 300 cc. | | 650 cc. | | 1060 cc. | | 1950 cc. | |
| | | | LEVINE TUBE→ | | 200 cc. | | 500 cc. | | 1400 cc. | | 1000 cc. | |
| PATIENT | AGE | OPERATION<br>LENGTH OF OPERATION | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. |
| | | | Gm./L<br>3/L | Mg.%<br>469 | Total<br>Gm.<br>.6 | Mg.%<br>464 | Total<br>Gm.<br>1. | Mg.%<br>452 | Total<br>Gm.<br>.2 | Mg.%<br>461 | Total<br>Gm.<br>5.5 | Mg.%<br>494 |
| 3<br>M. M. | 53 | SUBTOTAL GASTRECTOMY<br>2½ Hours | INTAKE IV→ | | 1000 cc. Blood<br>1000 cc. 5% G/W<br>0 | | 0<br>0<br>0 | | 2000 cc. Amigen<br>1000 cc. 5% G/W<br>500 cc. Blood | | 2000 cc. 5% G/W<br>1500 cc. 5% G/NSS<br>0 | |
| | | | INTAKE ORAL→ | | 210 cc. | | 130 cc. | | 800 cc. | | 900 cc. | |
| | | | URINE OUTPUT→ | | 200 cc. | | 440 cc. | | 1640 cc. | | 2120 cc. | |
| | | | LEVINE TUBE→ | | 100 cc. | | 0 | | 0 | | 0 | |
| PATIENT | AGE | OPERATION<br>LENGTH OF | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. | URINE CL. | BLD. CL. |
| | | | Gm./L<br>4/L | Mg.%<br>462 | Total<br>Gm.<br>1.6 | Mg.%<br>436 | Total<br>Gm.<br>.2 | Mg.%<br>469 | Total<br>Gm.<br>0 | Mg.%<br>480 | Total<br>Gm.<br>.9 | Mg.%<br>430 |
| 4<br>T. M. | 61 | COMMON DUCT DRAINAGE FOR CA. AMP.-VATER<br>2½ Hours | INTAKE IV→ | | 1500 cc. 5% G/W<br>500 cc. Blood | | 1000 cc. Amigen | | 1000 cc. 5% G/W<br>1000 cc. 5% G/NSS<br>1000 cc. Amigen | | 0 | |
| | | | INTAKE ORAL→ | | | | 0 | | 830 cc. | | 1750 cc. | |
| | | | URINE OUTPUT→ | | 400 cc. | | 650 cc. | | 780 cc. | | 1120 cc. | |
| | | | LEVINE TUBE→ | | 80 cc. | | 160 cc. | | 1666 cc. | | 250 cc. | |

normal at the sixty-sixth hour, when there was still an absence of salt excretion.

CASE 3. M. M., another case of subtotal gastrectomy, shows no alteration of the blood chloride levels during the test. There was a small amount of salt excreted until the twenty-sixth hour, then none until saline was given at the forty-eighth hour.

CASE 4. T. M. underwent a common duct drainage for inoperable carcinoma of the ampulla of Vater. He excreted a small amount of salt during the first two periods but none thereafter until the forty-eighth hour, 24 hours following the administration of 11.5 Gm. of salt. Since there was a urinary suppression during this period, it is probably indicative of temporary shock, and possibly a mild salt depletion. The blood chloride levels were within normal range except at the sixty-sixth hour. There was a loss of 8 Gm. of salt from gastric suction.

There was an average urinary output in this group at the eighth hour of only 285 cc.

## CONCLUSIONS

1. Because of the limitations of our present laboratory tests, it is important that thorough clinical appraisal of surgical patients be used in conjunction with our laboratory results in their preoperative preparation and postoperative treatment. Preoperative evaluation of surgical patients must be emphasized. In many patients, if this has not been done, it may be impossible postoperatively by clinical or laboratory means truly to determine their needs.

2. Excess sodium chloride given postoperatively in healthy young patients causes little difficulty as their serum proteins are high, their kidneys and heart are normal, and they can excrete the excess in 35 to 45 hours following operation. In elderly patients with a low kidney reserve, some protein depletion· extensive operative trauma, or some cardiac weakness, excess sodium chloride given postoperatively will cause a retention of water and electrolytes and greatly lessen their chances of recovery.

3. It is believed that if the patient has lost much from perspiration in a hot operating room, or if there was a preoperative depletion of electrolytes not already replaced, the patient will benefit by replacing that approximate loss the operative day.

4. If no saline has been given postoperatively, it is advisable to keep in mind that there will be some depletion at the thirty-sixth to forty-eighth postoperative hour, indicating the need of replacement of these electrolytes.

5. From the results in this study it appears that quantitative urinary sodium chloride determinations are helpful both preoperatively and postoperatively to determine the electrolyte needs of

patients, provided one is mindful that it is not an absolute guide and remembers the conditions in which it may be misleading.

6. High levels of urinary chlorides are almost always indicative of sodium chloride excess, but because of the possibility of retention of sodium chloride, low or absent urinary chlorides are not always indicative of salt depletion. One is usually safe in assuming a depletion if there is a normal urinary output and a zero level of urinary chlorides.

7. Qualitative urinary sodium chloride determinations taken at random to determine the electrolyte needs may be accurate if the patient has a normal urinary output for that period, but may be in error if the urine is too concentrated or dilute. It is suggested that if only occasional determinations are indicated, a six hour urine specimen be saved and the test run on the sample. If the postoperative patient excretes 250 cc. to 400 cc. of urine with a normal specific gravity, and .5 Gm. to 1 Gm. of salt during this period, it is usually indicative of a normal water and electrolyte balance.

8. From the results in this series and the studies of others, blood chloride show no true reflection of sodium chloride excess or moderate depletion.

9. It is necessary to use all adjuncts available to calculate fluid and electrolyte needs of postoperative patients. Important of these are: preoperative evaluation; replacement of operative losses; accurate record of intake, output and losses; frequent clinical appraisals; and appraisals of the patients' responses to therapy. One must remember that laboratory tests are only aids to accurate clinical recognition of therapeutic needs.

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## SURGICAL TREATMENT OF DUODENAL ULCER

The clinical and experimental studies of Dragstedt have established the relationship between vagal stimulation, hypersecretion of gastric juices, and the development of duodenal ulcer. Unlike gastric ulcer, in which the basic difficulty appears to be a lack of resistance of the gastric mucosa, duodenal ulcer is caused by hyperacidity and hypersecretion. Removal of four-fifths of the stomach, with its attendant mortality and morbidity, appears to be a high price to pay for correction of a defect that is basically a psychosomatic disturbance.

Although Moore's studies of the natural history of duodenal ulcer indicate that the mortality in medically treated cases may be higher than we have realized, the fact remains that duodenal ulcer is essentially a benign disease which is only rarely fatal. For this reason we are not justified in employing in its treatment any operation which carries a high mortality rate.

Most articles in the current literature report mortality rates between 1 per cent and 4 per cent, following gastric resection for

duodenal ulcer. This mortality, although still high, is not prohibitive, and in the hands of the expert surgeons who have attained such excellent results, gastric resection may be justified. But many well qualified surgeons operating independently without all the facilities of a large institution, have not been able to maintain a mortality rate below 5 per cent. Such a mortality rate should be considered prohibitively high.

Although neither vagotomy alone nor gastroenterostomy alone have proved satisfactory in the treatment of duodenal ulcer, the combination of vagotomy and gastroenterostomy has found acceptance among many surgeons throughout the country. These surgeons have recognized that the rationale of the operation is based on much sounder principles than is gastric resection. They have found that when the two operations are combined, they act synergistically to abolish the ulcer diathesis and diminish the incidence of recurrent ulceration well below that which follows the average gastric resection. Moreover they have found that the gastroenterostomy to a large extent eliminates the so-called side effects of vagotomy, and they have observed that the mortality and morbidity following this operation is much less than that which attends a resection of sufficient magnitude to afford comparable protection against recurrence of the ulcer.

Because many of the older and more experienced gastric surgeons have been unwilling to abandon their highly developed technic of gastric resection and adopt a new operation which they consider as yet unproved, there has been almost universal opposition to vagotomy and gastroenterostomy by this group. Despite this, the recent survey made by the American Gastroenterological Association indicates that in the smaller communities and wherever surgeons of either great or little experience have given vagotomy and gastroenterostomy a fair trial in a large series of consecutive cases, the results have been found to be excellent. In this survey of over 1,000 consecutive cases followed for one and one-half years or longer after vagotomy and gastroenterostomy, 98 per cent of the patients remained free of ulcer symptoms. Our own experience at the Cleveland Clinic in the past five years with over 400 patients operated upon for duodenal ulcer, similarly indicates clearly that vagotomy and gastroenterostomy is a better operation than resection for duodenal ulcer.

Since vagotomy and gastroenterostomy is attended by a much lower mortality, a lower morbidity and a comparable, if not superior, degree of protection against recurrent ulceration, surgeons whose mortality and morbidity following resection are high should

give serious consideration to abandoning resection in favor of vagotomy and gastroenterostomy. By the same token, even those surgeons whose mortality rate following gastric resection is low, might be able to effect still better results if they would adopt the safer and more physiologic operation of vagotomy and gastroenterostomy.

GEORGE CRILE, JR., M.D.

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# BOOK REVIEWS

*The Editors of* THE AMERICAN SURGEON *will at all times welcome new books in the field of surgery and will acknowledge their receipt in these pages. The editors do not, however, agree to review all books that have been submitted without solicitation.*

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SKULL FRACTURE AND BRAIN INJURY. By HARRY E. MOCK, M.D., Consulting Surgeon, Saint Luke's Hospital, Chicago; Associate Professor Emeritus of Surgery, Northwestern University School of Medicine, Baltimore, Williams and Wilkins Co., 1950. 806 pages, $13.50.

The underlying theme in this volume may well be expressed in this quotation from Senn: "No injuries of the skull are too extensive to be despaired of, and none too slight to be ignored." The author is an elderly general surgeon who, because of a bitter and lasting experience early in his practice some 40 years ago, made his hobby the subject of skull fracture and brain injury. The author suggests that "underlying most skull fractures is some brain injury. Many brain injuries occur with skull fractures. Both types of brain injuries require identical management. Certain skull fractures and brain injuries require specific management; therefore the title, *'Skull Fractures and Brain Injuries'.*"

The volume had its inception in 1928 when the author completed 10 years of research in management of these conditions. In 1931, as a result of that research, he presented his first skull fracture and brain injury exhibit to the American Medical Association. The author collected 20,000 cases from other surgeons all over the country and selected 10,834 as having enough information to be of real value; of these there were 7,747 proved or practically proved cases of skull fracture. Of these cases, the author has personally treated 1,139 serious brain injuries, only 432 of which had a fractured skull.

Throughout the volume the author takes every opportunity to express his feelings in no uncertain terms about the "trust in God treatment" of brain injuries.

The volume is developed along a sensible outline but is not written in the heavy scientific manner which characterizes most neurological and neurosurgical textbooks. He really begins after a lengthy introduction which is explanatory, rather than apologetic, by reviewing the mortality rates now as contrasted to 1900. He points out that the vast majority of brain injuries are sustained far from centers where neurosurgeons work and thus must be cared for by the local physician. In the statistics from the various hospitals that he has reviewed, he divides them into three categories: that is, good, average, or poor according to their mortality rate.

He next sets down "common sense principles and special rules" and cites one example after another in the form of a case report to prove his point. This is quite good and contains much good "horse sense." The chapter on etiology and prevention is of interest while the chapters on pathology, physiology, and physiopathology, although quite long, are full of valuable facts yet aren't adorned by the highly technical terminology usually expected in such works. The work on "signs and symptoms" is quite to the point.

The chapters on diagnosis and treatment read on for 249 pages during which time the author makes many false starts and takes the reader on many interesting side trips, which, while entertaining and worthwhile, aren't really neces-

sary. One of these side issues is his feud with Dr. Dandy as to when to do a spinal tap.

Next are several chapters on subdural hematoma, extradural hematoma, associated injuries and post-traumatic epilepsy.

In short, this is an interesting, worthwhile volume of the experiences of a lifetime in the treatment of brain and skull injuries, which, while interesting and easily readable, isn't very technically worded. It is illustrated by 230 examples, that is, short case reports, but, like this review, is much too long.

A. H. LETTON, M.D.

NORMAL ENCEPHALOGRAM. By LEO M. DAVIDOFF, M.D., and CORNELIUS G. DYKE, M.D. Third edition thoroughly revised by Leo M. Davidoff, M.D. Philadelphia, Lea and Febiger, 1951. 208 pages, $6.00.

This is the third edition of a book which has secured an irreplaceable position as an authoritative, as well as a reference, treatise.

The authors correlate exceedingly well the anatomical, physiological, and pathological background with the clinical indications and results of this procedure. A very thorough study of the roentgenographic appearance of the normal encephalogram is very well documented by the many excellent illustrations.

As a companion book with the "Abnormal Pneumoencephalogram," recently published, it is indispensable to the special fields interested in this clinical diagnostic procedure.

ROBERT F. MABON, M.D.

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*Books received are acknowledged in this section, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.*

*Your Prostate Gland,* by Reed M. Nesbit, M.D., Professor of Surgery, University of Michigan Medical School; Chief, Section on Urology, University Hospital, Ann Arbor, Mich., Charles C Thomas, Springfield, Ill. 50 pages, $2.00.

*Synopsis of Surgical Anatomy,* by Alexander Lee McGregor, M.Ch. (Edin.), F.R.C.S. (Eng.), Senior Surgeon, Johannesburg General Hospital, Lecturer in Surgery, University of the Witwatersrand, Seventh Edition, The Williams and Wilkins Co., Baltimore, 1950. 746 illustrations, 778 pages.

*The Microkaryocytes, The Fourth Corpuscles and their Functions,* by K. G. Khorozian, A.B., M.S., M.D., Pineville, W. Va., Meader Publishing Co., Boston, 1951. 969 pages, $12.00.

*Introduction to Surgery,* by Virginia Kneeland Frantz, M.D., Associate Professor of Surgery, College of Physicians and Surgeons, Columbia Univ.; Associate Attending Surgeon, Pathologist, Presbyterian Hospital, N. Y., and by Harold Dortic Harvey, M.D., Assistant Professor of Clinical Surgery, College of Physicians and Surgeons, Columbia University; Associate Attending Surgeon, Presly Hospital, N. Y., Oxford University Press, New York, 1951. 232 pages, $2.75.

# ABSTRACTS FROM CURRENT LITERATURE

POTASSIUM LOSS IN EXPERIMENTAL INTESTINAL OBSTRUCTION. J. A. Schilling, A. B. McCord, and S. W. Claussen. *Surgery, Gynecology and Obstetrics 92*:1-13 (Jan.) 1950.

The authors have studied potassium loss in the vomitus, intestine, and peritoneal cavity in intestinal obstruction to determine if this loss be great enough to account for some of the toxic symptoms not already explained by dehydration, infection, sodium loss, and reduced blood volume. Using healthy young mongrel dogs, an isolated segment of upper jejunum was prepared, the bowel anastomosed at that point and then completely obstructed at a variable point along the course of the small bowel by complete interruption of the bowel with closure of both open ends. In certain animals, devascularized segments of bowel were prepared. A jejunal fistula was prepared in two dogs for the study of losses into the bowel lumen. The animals had been studied in metabolism cages on a standard diet for a period prior to the time obstruction was effected. Muscle biopsies were taken from the animals at appropriate intervals and studied. Careful observations in regard to losses of sodium and potassium via the various routes were made. The variations produced by administration of sodium and potassium were studied. Results of the experiments are presented in carefully prepared graphic and tabular figures. Analysis of these results has led the authors to the following conclusions which are quoted in part:

"The acute loss of potassium under the above conditions was relatively small and did not exceed 4 per cent of the body total compared with the acute loss of sodium which approximated 25 per cent of the body total in certain instances.

"There is an important and prompt interchange within the cell between sodium and potassium following administration of one of these cations.

"Potassium when displaced is excreted promptly in the urine despite total body depletion.

"Under the above experimental conditions with a negative nitrogen balance there was no retention of potassium following its administration. Retention of sodium always occurred with a delayed diuresis.

"The concentrations of sodium and potassium in normal intestinal secretions remained remarkably constant during excess administration and depletion.

"Serum concentrations of sodium and potassium also remained quite constant except terminally in some moribund animals when there was a lowering of sodium and a sharp rise of potassium levels.

"The sodium concentration is approximately equal to and the potassium concentration is several times greater than their respective serum levels in abnormal fluids lost during intestinal obstruction.

"The varying levels of potassium concentration in abnormal fluids seemed to reflect the degree of strangulation and necrosis of the obstructed intestinal loops.

"Within the cell there was a tendency for greater sodium depletion than potassium.

"Potassium loss *per se* was not toxic under the experimental conditions mentioned but was intimately related to the relatively greater sodium and water loss and the corresponding intracellular and extracellular readjustments."

R. H. S.

THE TREND TOWARD COMPLETE HYSTERECTOMY. Irving F. Stein. *Western Journal of Surgery, Obstetrics and Gynecology 59*:6-12 (Jan.) 1951.

The author observes that while the general surgeon performs the majority of hysterectomies and for the most part continues to do the subtotal operation, the trend is definitely toward the complete operation. This has been accelerated by the recognized significance of surgical stump disease. Frequent persistence of pelvic pain, dyspareunia, urinary frequency, dysuria and cervical discharge following subtotal hysterectomy and persisting until the cervical stump is removed have also prompted increase in the relative frequency with which total hysterectomy is performed.

Following a brief discussion of the indications for hysterectomy and of diagnostic principles involved, Stein presents his criteria concerning the selection of method. "When complete hysterectomy would constitute a greater danger to the patient because of increased vascularity of the pelvic structures, or fixation to adjacent organs as bladder and rectum—such as in frozen pelves or extensive endometriosis—and when the cervix is free from demonstrable disease, one may justifiably perform a *subtotal hysterectomy*. In patients who are poor risks for the total operation, and those in whom exposure of the pelvic organs proves difficult, it is wiser to perform the partial operation."

Stein states that complete hysterectomy either by the abdominal or vaginal routes is preferable in all cases except those enumerated above. He lists as reasons for selection of the total abdominal operation for benign uterine disease, the following:

1. It is possible that an unsuspected carcinoma of the cervix would be allowed to remain if partial hysterectomy were done.

2. It is considered by many operators as a prophylactic measure against the subsequent development of carcinoma of the stump.

3. The chronically inflamed cervix which may be responsible for many of the patient's symptoms is thereby eradicated.

4. Prolapse of the vaginal vault is rarely observed after complete hysterectomy.

Stein points out that though total abdominal hysterectomy requires greater skill and some experience, the technic is easily learned and objection to the operation on this basis is not valid. He altogether discounts the frequently voiced complaint that the total operation produces shortening of the vagina since the total length of the vagina is preserved when the operation is performed in the approved manner. He concludes that the trend toward complete hysterectomy is justifiable.

At the Michael Reese Hospital during the year preceding the report, 94 per cent of the hysterectomies were complete. There were no deaths in this group of 561 patients.

R. H. S.

MALIGNANT TUMORS OF THE DUODENUM. David Henry Poer. *Southern Medical Journal 44:29-33* (Jan.) 1951.

Malignant tumors of the duodenum are rare. Such a tumor is found in about 0.03 per cent of necropsies and accounts for only about 0.3 per cent of gastrointestinal malignancies. Poer classifies the malignant tumors of the duodenum as follows:

1. Carcinoma of the ampulla of Vater.
2. Carcinoid or argentaffine cell tumors.
3. Sarcomas (leiomyosarcoma, myxosarcoma, lymphosarcoma, etc.).
4. Carcinomas, exclusive of those of the ampullary region.

Four case reports are presented, each illustrative of one of the above types. One of the cases reported is that of a 40 year old man who was operated on because of an acute perforation of a lesion of the anterior surface of the first portion of the duodenum. The lesion was excised and the duodenum closed. The true nature of the lesion was missed on pathological examination and it was not until later, when obstruction developed and appeared in the old operative scar, that the diagnosis of lymphosarcoma was made. Review of the original microscopic sections revealed a similar pattern.

The author presents a brief review of the symptomatology of duodenal malignancy. Though the index of suspicion of the examining physician builds the groundwork for making the diagnosis, definitive morphological diagnosis depends upon the roentgenologist who must be encouraged to extend his examination to the entire duodenum. It becomes the surgeon's responsibility to demonstrate conclusively the organic cause for obstructive jaundice. If after exploration of common duct and palpation of the duodenum no gross lesion is demonstrated, duodenotomy with direct visualization and palpation of the ampulla may demonstrate a lesion, benign or malignant, too small for accurate palpation.

Poer feels that earlier diagnosis, an increasingly aggressive attitude toward radical surgery in abdominal cancer, and our constantly improving supportive and therapeutic adjuncts must certainly accomplish improvement in percentage of cure of these lesions.

R. H. S.

POTASSIUM AND WOUND HEALING. Charles W. Findlay, Jr., and Edward L. Howes. *Surgery 28:970-976* (Dec.) 1950.

In order to determine the effect of tissue depletion of potassium on the healing of wounds, rats were fed on low and average potassium diets and their wounds were tested for strength at intervals during the healing process and changes in concentrations of potassium and sodium in the muscles were studied. The diets proposed by Darrow were used and after the rats had been upon the diets for 21 days the abdominal skin was incised and closed. The animals were sacrificed at intervals from 2 to 10 days, the wounds carefully marked off in centimeter segments and the wounds excised with excess skin on either side of the wound. The centimeter wide strips were then cut and their tensile strength in grams determined. Specimens of muscle tissue from each animal were studied for potassium and sodium content.

A comparison of curves plotted from the wound strength determinations

revealed that the curves for the potassium depleted animals and the controls closely followed each other. Comparisons of the potassium content of the muscle tissue revealed a statistically significant difference. This lowering of the potassium content of the muscle by the potassium deficient feedings was counteracted in a number of animals which weer treated postoperatively with KCl clyses.

"In conclusion, it appears that, following injury, the potassium depleted animal eventually redistributes endogenous potassium to maintain the potas-counteracted in a number of animals which were treated postoperatively with sium content of muscle, and that healing processes are not altered. Correspondingly, clinical potassium deficiencies, unless they accompany some other change in an auxiliary metabolite that affects healing, should not affect the acquisition of tensile strength by the healing wound."

R. H. S.

EVALUATION OF CHLOROMYCETIN AS AN ADJUNCT TO THE SURGICAL MANAGEMENT OF LYMPHOGRANULOMA VENEREUM AND SEGMENTAL ULCERATIVE COLITIS. Robert J. Rowe. *American Journal of Surgery 81*:42-54 (Jan.) 1951.

Although the sulfonamides and the earlier autibiotics have been useful in combating the secondary infection associated with lymphogranuloma venereum, until recently no specific therapeutic agent has been effective in impeding its devastating effects upon the lower bowel and anorectum. Smadel and Jackson reported in 1948 that chloromycetin was effective in experimental infections due to the psittacosis and the lymphogranuloma viruses. Since a relatively large number of patients with lymphogranuloma venereum are seen at the Dallas Syphilis and Venereal Disease Clinic and on the proctology service of the Dallas City-County Hospital, Rowe requested and obtained adequate amounts of Chloromycetin for clinical evaluation of the drug in lymphogranuloma venereum. A total of 32 patients have been treated (this number includes 4 patients with nonspecific segmental ulcerative colitis).

After a review of recent advances related to the etiology, incidence, pathology, diagnosis and treatment of the disease and a brief presentation of the history of the development of chloromycetin, the author presents the results of treatment of these cases in tabular form together with a discussion of methods and results.

Patients have been classified in four categories: nodular ulcerative proctitis (3 patients), ulcerative proctitis with stricture (11 patients), acute genital and inguinal lesions (18 patients) and nonspecific ulcerative intestinal disease (4 patients). Rowe concludes that, though inconclusive, the results obtained indicate that choloromycetin has a specific activity against the virus of lymphogranuloma venereum. It seemed to effect a cure in the acute cases and palliation in the more advanced rectal lesions. It may preclude radical surgical intervention except in the more advanced rectal strictures and in these cases should prove a valuable adjunct in preoperative preparation of the patient.

The results obtained in the 4 patients with nonspecific ulcerative disease indicate the chloromycetin may be of therapeutic value in combating secondary infection but probably has no effect on the causative agent of the disease.

R. H. S.

BILIARY TRACT SURGERY IN A SMALL COMMUNITY HOSPITAL. A Ten Year Survey. Caleb H. Smith, C. D. Walther, D. H. Maunz, S. A. McCutcheon, and E. J. Medden. *Annals of Surgery 132*:1086-1092 (Dec.) 1950.

Noting the paucity of papers concerning biliary disease emanating from hospitals in small communities, the authors feel that such a report is justified for several reasons. Such a report offers data that upon comparison with those issuing from larger centers supplies an index of the utilization by surgeons in outlying districts of the advances made in teaching centers. The current sociologic interest in medicine purporting relatively poor care for persons in rural areas would seem to demand the communication of accurate information. Finally, a definite difference in circumstance of the surgical approach is evident when a specific problem is met in a rural hospital as compared with that in a medical center. It would seem that there is opportunity in a small community to consider the disease process in an earlier phase.

During a 10 year period ending May, 1948, there were 348 operations performed on the biliary tract in the 128 bed Bradford hospital in Bradford, Pennsylvania. These operations were performed by four general surgeons. Only in the later years was a resident surgical assistant available, student nurses serving as surgical assistant in the earlier years. An over-all mortality of 2 per cent occurred. In 85 cases of acute cholecystitis, 78 cholecystectomies, 7 cholecystostomies, and 24 choledochostomies were performed with a mortality of 3.5 per cent. Patients with acute cholecystitis were considered to be emergencies and as soon as they could be properly prepared, surgery was undertaken. The authors feel that such a plan is particularly appropriate in a small community since surgeons are apt to see the patient earlier in the disease.

Cholecystectomy was performed 246 times for chronic cholecystitis with a mortality of 1.2 per cent. During the latter five years, the mortality was 0.7 per cent in 139 cases. The common bile duct was explored in 36 per cent of the patients and stones were found in 13 per cent of all patients operated on for acute or chronic cholecystitis. There was a higher per cent of exploration of the common duct during the latter five years as compared with the earlier five year period. There was no increased mortality from exploration of the duct.

The authors conclude that biliary tract surgery performed in a small community hospital compares favorably with that done in large metropolitan hospitals.

R. H. S.

ANNULAR PANCREAS. Mark M. Ravitch and Alan C. Woods. *Annals of Surgery 132*:1116-1127 (Dec.) 1950.

There have now been reported some 50 instances of annular pancreas in human beings and 14 recorded instances of operation for this rare anomaly. At operation or autopsy, the anomaly is manifest as a thin flat band of grossly recognizable and apparently normal pancreatic tissue anterior to the duodenum in its second portion. The tissue encircles the duodenum completely and is continuous with the head of the pancreas. In certain instances, it lies loosely upon the duodenum and is easily separated.

In many instances, the anomaly is asymptomatic. In 14 instances—17 including the 3 reported herein—sufficient symptoms were produced to warrant operation. Sixteen of the 17 patients developed signs of high intestinal obstruc-

tion. The seventeenth was operated on for peritonitis found to be due to acute pancreatitis. Most of the patients were well along in years before the symptoms began and only 4 were in the neonatal period. In the older patients, indigestion, eructation, and vague epigastric distress preceded the onset of frank intestinal obstruction. Because of the rarity of the lesion, the correct diagnosis is seldom made. It may be made in patients with chronic duodenal obstruction who show by x-ray an almost complete, smooth and sharp obstruction to the right of the midline.

Of the 17 operative cases, 7 were treated by direct attack and excision of the ring. This resulted in one straightforward cure, one death, three instances of prolonged pancreatic drainage and two instances of persistence of symptoms. The remaining 10 cases were all treated by some form of by-pass operation. In this group, there were 3 deaths all occurring before the era of antibiotics and multiple transfusion. Two of these deaths were due to upper respiratory infections and the other one died a few hours after operation presumably of shock. Ravitch and Woods feel that duodenojejunostomy is probably the procedure of choice.

Herein are reported 3 additional cases of annular pancreas. One of these was a case of a 67 year old man and the other 2 were infants. One of the infants presented associated anomalies of the colon. This particular case was treated by gastroduodenostomy. The others were treated with duodenojejunostomy. Good results were obtained in all three instances. Reproductions of the x-ray findings in all 3 cases are included.

R. H. S.

INFLUENCE OF ANTIBIOTICS AND SULFONAMIDES ON THE MORTALITY AND BACTERIA OF EXPERIMENTAL PERITONITIS. H. A. Zintel, H. H. Zinsser, W. Runyon, G. L. Jackson, A. C. Nichols, M. M. Wiley, and W. J. Williams. *Surgery, Gynecology and Obstetrics 91*:742-750 (Dec.) 1950.

"It is now agreed that the use of the sulfonamides and the antibiotics has been associated with a substantial reduction in the morbidity and mortality of patients with peritonitis. Yet it is difficult to evaluate the exact role these chemotherapeutic agents have played in the recovery of such patients. . . . It is of considerable interest that the morbidity and mortality of peritonitis have been favorably influenced by penicillin therapy in spite of the fact that many of the bacteria most frequently found in this type of polymicrobic infection are not susceptible to the action of penicillin *in vitro*. . . ."

The purpose of the experiment reported herein was to determine the relative effectiveness of penicillin, streptomycin, and combinations of penicillin, streptomycin and sulfonamides in the treatment of experimentally produced peritonitis in dogs. Peritonitis was produced in 107 mongrel dogs by devascularization, ligation and incision of the vermiform appendix with deliberate widespread peritoneal contamination. The animals were divided into several groups treated with the various agents alone and in combination. A control group received no treatment. Dogs dying before the tenth postoperative day were autopsied and terminal cultures obtained for comparison with cultures obtained from the appendiceal lumen at time of operation. Animals surviving until the tenth postoperative day were sacrificed and similar studies made. Results of the experiment are presented in graphic and tabular form. After studying the data, the authors were able to draw the following conclusions:

"1. Penicillin therapy alone over a period of 10 days was as effective as a combination of penicillin and streptomycin or a combination of penicillin, streptomycin, and sulfonamides in the treatment of experimentally produced peritonitis in dogs.

"2. Streptomycin alone did produce a decreased mortality as compared to the control dogs; however, the results were definitely inferior to those with penicillin alone, with a combination of penicillin and streptomycin, or with a combination of penicillin, streptomycin and sulfonamides.

"3. Death or survival of the dogs in any given group could not be correlated with a difference in the initial or terminal number of bacterial types or strains present in the peritoneal cavity.

"4. Frequently now forms of bacteria which were not present in the initial cultures of the peritoneal cavity were found on terminal cultures.

"5. From the available bacteriological data it was not possible to designate one bacterial organism or any combination of the three most commonly encountered bacterial organisms (Escherichia coli, streptococci, and clostridia) as being responsible for the mortality of the peritonitis in these dogs.

"6. Of the six most commonly found bacterial organisms it was not possible to predict the result of penicillin or penicillin and streptomycin therapy on the basis of the antibiotic sensitivities of the bacterial organisms found in the initial cultures.

"7. Bacterial organisms sensitive to the antibiotics used for treatment were frequently found in the peritoneal cavity on terminal culture both in the animals that lived and those that died.

"8. Preoperative treatment with distemper vaccine and specific therapy for intestinal parasites did not alter the mortality of experimentally produced peritonitis."

R. H. S.

ANESTHESIA IN THE NEWBORN. G. Jackson Rees. *British Medical Journal* 2:1419-1422 (Dec. 23) 1950.

With increasing knowledge of the surgical treatment of congenital anomalies, many more newborn infants are submitted to surgery than in previous years. Anesthetists have found it necessary to readjust their approach to anesthesia for these very small patients. Local anesthesia has been the choice, but if general anesthesia can be made safe and at the same time produce easier working conditions for the surgeon, it is likely to become the choice. This already has been the case in most abdominal and thoracic cases. The aim of the anesthetist is to develop a technic which overcomes the resistance in the air passages of the infant, avoids excessive rebreathing, and maintains light anesthesia.

Thoracic movement plays little part in the respiratory activity during the neonatal period, respiration normally being accomplished by the diaphragm and abdominal muscles. The infant's comparatively large respiratory minute volume is probably the effect of its relatively large surface area. Since tidal air volume in the infant is 19 cc. and the vital capacity about 170 cc., the relatively larger minute volume in the infant develops from rapidity rather than increase in depth. Anatomically, the infant's tracheobronchial tree is adapted to counteract the small area available for respiratory exchange since the diameter of the neonatal trachea is twice that at 12 months in proportion to the

lung volume. Due to a varied response to carbon dioxide level, the infant cannot be relied on to react to varying concentrations, but acapnia is generally easily produced by depletion of carbon dioxide, thus allowing complete control of respiration.

The technic described in this paper utilizes several of these principles. For abdominal and thoracic work, endotracheal ether is used. The presence of the tube assures an airway for control of respiration and reduces the dead space to a minimum. No sub-glottic edema is reported by the author. The infant is unable to exhibit the reflex contractions of the cervical muscles (bucking) which are seen in the adult on intubation. The reactions in the infant are an active pharyngeal reflex and a facial appearance of being about to cry. Under light anesthesia, the facial sign is absent, and the only sign on insertion of the tube is a disturbance of respiratory rhythm. From birth to about 24 hours after delivery, increasing quantities of air enter the gastrointestinal tract. This inevitably causes crowding of the abdominal cavity which, in addition to diaphragmmatic breathing peculiar to the newborn, tend to cause turbulence in the operative field.

With the use of an endotracheal tube and controlled respirations made possible by acapania produced through natural means (without curare), the author sets forth a technic which uses natural conditions to ease the task of the anesthetist, quiet the field for the surgeon and permit the use of minimal amounts of the safest anesthetic agent, ether.

LESTER RUMBLE, JR.